# REPORT RESUMES

ED 019 005 EM 006 667

PROGRAMMED LEARNING IN CENTRAL AFRICAN CONTEXTS.
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REPORT NUMBER UCRS-FE-OP-7
EDRS PRICE MF-$0.50 HC-$3.72 91P.

DESCRIPTORS- *PROGRAMED INSTRUCTION, *PROGRAMED MATERIALS, *EVALUATION, *NEGRO EDUCATION, ADULT EDUCATION, LINEAR PROGRAMING, MULTICHANNEL PROGRAMING, PROFESSIONAL EDUCATION, VOCATIONAL EDUCATION, DISCUSSION (TEACHING TECHNIQUE), PERFORMANCE TESTS, SECONDARY EDUCATION, EDUCATION, SCIENCE EDUCATION, ADULT EDUCATION, SECONDARY EDUCATION, ELEMENTARY EDUCATION, HEALTH EDUCATION, CULTURAL EDUCATION, TRADE AND INDUSTRIAL EDUCATION, EDUCATIONAL RESEARCH, AFRICA, RHODESIA, ZAMBIA

SINCE 1964, THE PROGRAMMED LEARNING CENTRE AT THE UNIVERSITY COLLEGE OF RHODESIA HAS BEEN INVESTIGATING THE POTENTIALITIES OF PROGRAMED LEARNING FOR CENTRAL AFRICA THROUGH A SERIES OF CONTROLLED EXPERIMENTS USING LOCALLY-WRITTEN AND PUBLISHED PROGRAMS. ASSESSMENT OF THE DESIRABILITY AND USEFULNESS OF PROGRAMS IN TEACHING, AND ASSESSMENT OF THEIR ABILITY TO MOTIVATE AND TO TEACH PROBLEM-SOLVING APPROACHES AND CREATIVITY ARE RESEARCH PROBLEMS OF PRAGMATIC INTEREST DUE TO THE PRESSING NEED FOR TRAINED MANPOWER IN INDUSTRY AND MEDICINE. PROGRAMS DEALING WITH TOPICS SUCH AS SIMPLE CONTOURS, HOW PEOPLE LEARN, AND THE 1802 FACTORY REFORM ACT HAVE BEEN TESTED WITH GENERALLY FAVORABLE RESULTS. TOPICS HAVING EMOTIONAL CONTENT ARE MORE EFFECTIVELY TAUGHT THROUGH DISCUSSIONS, IN WHICH PARTICIPANTS CAN VOICE THEIR OPINIONS, THAN THROUGH PROGRAMS. OTHER LONGER-TERM AND LESS RIGOROUSLY CONTROLLED IN-SCHOOL TRIALS OF PROGRAMS HAVE GIVEN VARYING RESULTS. MUCH RESEARCH IS STILL IN PROGRESS. THE APPENDIX CONTAINS A CATALOG OF HOLDINGS AT THE PROGRAMMED LEARNING CENTRE. AN INDEX IS INCLUDED. (BB)

FACULTY OF
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PAPER No. 7

ED019005

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UNIVERSITY COLLEGE OF RHODESIA

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D. G. HAWKRIDGE

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# CHAPTER ONE

# INTRODUCTION

## The Operational Basis

The general history of the development of the programmed learning movement does not need to be rehearsed in full in a publication of this nature. The pioneering work of Sidney L. Pressey in the 1920's drew attention to the possibilities of devices which could afford assistance to the teacher by providing self-correction. The work of B. F. Skinner at Harvard, culminating in the publication of his article, "The Science of Learning and the Art of Teaching", in 1954, marked the intrusion of operant conditioning into the classroom. The contribution made by Norman A. Crowder towards the establishment of intrinsic programming, particularly for use in machines, must also be noted.

Since 1954, programmed learning as a teaching technique has become the subject of experimental work in most Western countries. Whilst the United States led the way in the early years, educationists in Russia, Great Britain, Western Germany, Australia and many other parts of the world have wished to test the claim made for programmed learning that it is the technique which best applies the basic principles of psychology in the classroom. In Great Britain, for example, research of some kind in the field of programmed learning is proceeding at almost every University. The Government has recognised the potential of the technique by making a considerable grant for the establishment of a Documentation Centre at Birmingham University.

This is not to say that the technique is to be found in Universities alone; in fact, the most widespread use of programmed learning has been in industry and commerce. The schools have also conducted large-scale experiments in using it. Reports of such research are listed in the Appendix.

Programmed learning was first brought to the notice of teachers in Central Africa by the Federal Ministry of Education in 1963. Accounts of some of the early trials of published materials are contained in Chapter 4. These trials were not carried out as properly controlled experiments; as the reports show, they comprised more a test of pupil and teacher reaction than a detailed assessment of the programmes.

It would be true to say that programmed learning research in Central Africa began in January, 1964, when the first steps were taken towards the establishment of a Programmed Learning Centre within the Faculty of Education of the University College of Rhodesia and Nyasaland, at Salisbury. Immediate interest was expressed from both Zambia and Rhodesia by a wide range of persons and bodies. This interest has broadened considerably since.

## Interested persons and bodies

(a) *Official:* The Rhodesian Ministry of Education has taken a direct interest in the application of programmed learning, particularly for African schools and correspondence education. This interest has not extended to financial support as yet, but the research has received encouragement from senior ministry officials.

The Rhodesian Heads of High Schools Association has asked to be kept informed. Individual heads have been most generous in their support for experiments in their schools, some 20 of which have become involved in the work.

The Teachers' Colleges at Bulawayo, Chalimbana and Gwelo have expressed interest, and members of their staffs are ready to carry out experiments.

The Royal Rhodesia Air Force is developing programming as a training technique for ground staff.

The Rhodesia Railways have introduced programming for in-service training and re-training.

Mpilo Central Hospital (African) in Bulawayo has a programming group investigating the use of programmed learning for teaching African student-nurses and other trainees.

The Rhodesian Public Service Commission Training Centre has adopted programmed learning as a training technique, and is testing several of its own programmes.

The Rhodesian Department of Civil Aviation, the Standard Bank, Salisbury Municipality, Kitwe Municipality, the Rhodesian Department of Conservation and Extension, the Rhodesian Ministry of Interal Affairs, I.C.T., the Rhodesian Ministry of Posts, and the Rhodesian Forestry Commission have all sent delegates to training seminars.

The Zambian copper companies requested a seminar for members of their training staffs. A Zambian building society expects to employ programmed learning to assist its drive to Zambianize its staff.

The Departments of Physiology (Faculty of Medicine) and Biological Science (Faculty of Science) at the University College have used published programmes to teach parts of regular courses under proper experimental conditions. The Faculty of Education has also made use of published programmes for teaching.

(b) *Personal:* About 250 persons in all parts of Central Africa are known to be interested in programmed learning and have asked to be kept informed. Many of these people call at the University College when in Salisbury to examine and borrow materials from the Reference Division of the Programmed Learning Centre. A further 250 persons in many countries receive information concerning programmed learning research in Central Africa through a quarterly bulletin.

### State of Research

The Programmed Learning Centre was originally established with assistance from U.N. Special Fund subventions. The purposes of the Centre have been stated as: (a) to facilitate research into the potential of programmed learning in the African context, with particular reference to the use of programmed learning in African secondary schools, for in-service teacher education, and for industrial training; and (b) to offer training facilities to industry, commerce and government, that is, to persons associated with all three departments of the Faculty of Education, in the techniques of programmed learning and the use of teaching machines.

The plan of development for the Centre is threefold:

(a) *Reference Division:* This division contains an extensive collection of available programmed texts (over 525), programmes for machines (38), machines and devices (17 models), books on programmed learning (about 90), research reports (420) and article references (1,500). The collection is open to all accredited persons. Borrowers at present include school teachers, students and staff of the University College, and instructors and trainers from a wide range of professions and occupations.

(b) *Research Division:* Under the auspices of this division about fifty programmes are at present being validated. About twenty other programmes are in the course of being written or are held in reserve.

The Research Division is responsible for supervising controlled experiments using not only locally-written programmes but also published ones. Experiments using the latter are mentioned above, except for one carried out in a girls' high school in Salisbury.

Other tasks of the Research Division are to examine and utilize the mass of research data flowing to the Centre from overseas, and to validate published programmes adapted to suit local conditions in Central Africa.

(c) *Report Division:* The creation of a climate of opinion favourable to *research* in programmed learning is one of the tasks of this division. The *Information Bulletin* mentioned above helps by maintaining liaison between those actively working in the field and those who are interested but not actively engaged in research. Further details of research have been published in:

OVAC Bulletin (London)
Programmiertes Lernen und programmierter Unterricht (Berlin)
The Journal of Programmed Learning (London)
Teacher Education (London)
New Education (London)
The Journal of Medical Education (U.S.A.).

The following seminars have been held, some short one-day meetings for information only, others training seminars for programmers, lasting three to five days:—

1964 University College of Rhodesia staff
Chalimbana Training College staff
Bulawayo Teachers' College staff
Bulawayo Teachers' College students.

1965 Zambian copper company staff
Teacher trainers
Diploma in Education students
Postgraduate Certificate in Education students
Technical and vocational trainers (twice)
Bulawayo hospitals staff.

1966 Rhodesia Railways staff
Diploma in Education students
Postgraduate Certificate in Education students.

From these seminars has come a large body of people (over 200) who are well-informed regarding programmed learning.

A small number of experiments began independently of the Programmed Learning Centre, but most of these are now proceeding on a co-operative basis, the Centre supplying help wherever it can.

### Summary of Contents

Chapter Two of this publication contains some of the editorial commentaries which have appeared in issues of the *Information Bulletin*. They serve to identify some areas for research and to reflect changes in emphasis in the work and thinking of persons connected with programmed learning research in Central Africa during 1964-1966.

More concrete evidence of the experiments so far undertaken is provided in Chapter Three, in which are reprinted the majority of the first twenty *Technical Reports on Programmes and Validations*. These, too, first appeared in the *Information Bulletin*, but have been rearranged for better continuity.

Chapter Four contains details of several large experiments for which reports were made available by the persons concerned, and an account of most of the continuing work in the field of programmed learning in Central Africa.

The Appendix is intended to serve as a reference for anybody interested in establishing similar research in a developing country. The lists it contains provide information concerning a variety of equipment and materials.

# CHAPTER TWO

## AREAS FOR RESEARCH

A pressing question which has to be answered through programmed learning research generally, and particularly such research in Africa, is whether teaching machines are necessary or desirable. A second question, perhaps less urgent, is whether one should use linear programmes or branching ones. Brief examination of these questions will indicate that they are closely related, since the effectiveness of branching programmes seems to be limited to some extent by their mode of presentation.

Branching programmes presented in the form of scrambled textbooks suffer from the disadvantage of causing the learner to fumble with pages to find the next step. A machine overcomes this difficulty by offering the pupil a series of buttons to press. Furthermore, in a scrambled text two-thirds or more of the pages may not be used by the majority of learners for whom the book is intended. Machines to take branching-type programmes are generally expensive, and need a power source. The case seems to be a poor one for using branching programmes in Africa, if we consider it from the point of view of expense (in the case of machines) or ease of presentation (in the case of scrambled books). Research may provide us with evidence to support the case, but it has not done so yet.

Insufficient research has been completed oveseas for us to be sure of the psychological implications for the learner using either branching or linear programmes. It is generally suggested that the branching programme, by offering the learner considerable information regarding any mistakes he may make, is able to guide him to a better "Gestalt" than a linear programme. Antagonists of the behaviouristic school of psychology have pointed to linear programming as an inadequate, mechanistic form of learning, which treats the learner as an animal to be trained to the correct response. By such people we are told that pupils are not pigeons, and that the severely analytical approach of the step by step linear programmers does not lead to insight nor to the formation of favourable "Gestalten".

Outside Africa these matters are being pursued by research psychologists. Inside Africa there is a strong tendency to accept on a pragmatic basis anything that does the job.

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Norbert Wiener, in a book entitled "The Human Use of Human Beings", made a plea for man to employ man in tasks which were worthy of man's dignity as a conscious, thinking being. In Africa, where so many men are daily engaged in subsistence labour of a kind which is chiefly mechanical and repetitive, not conducive to creative thought, Wiener's plea may seem so idealistic that we brush it off. The idea that Africa's millions may be freed one day from menial tasks to engage more fully in the creative process called thinking and inventing seems a far distant one.

Equally so, the idea that teachers are engaged in menial tasks not worthy of their intellect may seem strange to us. The fact is that a very elementary machine, such as that developed by Sidney L. Pressey forty years ago, can do the mass of certain kinds of marking for us. Many teachers stagger home with piles of books for correction, thereby loading themselves with mechanical tasks not entirely unrelated to hoeing and ploughing, thereby depriving their pupils of opportunities to develop perception by self-evaluation and assessment. The teachers are rated by many as conscientious. Undoubtedly they are. But may not their diligence be misguided?

If pupils are to learn to think for themselves they must be taught to ask the right questions of themselves: they must learn to give the answer and to evaluate it. In other contexts this learning sequence has been described as "developing a problem-solving approach", or indulging in "guided discovery". Clearly it is a desirable objective.

Programmed learning may help or hinder this process. Some programmes we have seen require scarcely any reasoning. Others develop concepts and understandings to a high level. We should beware of the first category. They are not hard to identify. Research can help to produce fine programmes of the second category.

* * *

One of the most urgent problems facing developing countries is that of providing trained manpower for industrialization. Inflow of capital from sources such as the World Bank does not fulfil its purpose if it is not supplemented by adequate resources of people trained in industrial skills, from fitting and turning to top-level management.

A country like Zambia is faced with the need to take special account of those industries (and particularly the copper mining industry) which generate its income and prosperity. Trained personnel for these industries can come from two sources. The first is from overseas: skilled artisans, plant managers and senior executives from overseas are still needed.

It seems likely, however, that as more Zambians complete their secondary education, particularly on the science side, Zambianization will proceed. Few would venture to attach a time-scale to this process, but sooner or later (and probably sooner), many new Zambian workers will be entering industry in Zambia. They *must* be trained properly if they are to become the main source of skilled manpower for Zambian industry.

It would be wrong for us to assume automatically that older conventional methods of training will suffice in the training situation likely to emerge in Zambia. Already, very real difficulties have been experienced in the "translation" of conventional training syllabuses and techniques for people coming from a different cultural background.

Perhaps programmed learning can be of help, embodying as it does rigid testing procedures for the training material. During such testing many of the difficulties of trainees are revealed, and the material may be revised to suit the trainees concerned. The actual process of writing the material itself normally involves a careful reappraisal of what is to be taught.

Work presently progressing in Zambia and Rhodesia should begin to answer the question: Where and how can programmed learning assist in industrial training in developing countries in Africa?

* * *

A question which has been asked frequently by those deeply concerned with education on their first encounter with programmed learning is this: Can programmes teach for creativity?

To put it another way, we may ask whether programmed materials induce convergent thinking (in Guilford's phrase) rather than divergent.

Pribram has something most pertinent to say about this matter:

> "We harbour many misconceptions about creativity. According to the most prevalent misconception, discoveries and inventions arise out of the blue. But the contrary is the case. In reality, discoverers make their discoveries through what they already know: they match the unfamiliar against a thoroughly incorporated body of fact. Columbus for example knew a great deal about navigation. He knew the assumed boundaries of the flat world and what could be expected if, as some people suspected, the world were really round. The inventor achieves novelty within the bounds of certainty."

In this context, we could also quote Wertheimer's classic work with Einstein, reported in the former's book, *Productive Thinking*. Here we see traced the steps by which Einstein arrived at his theory of relativity; there is no doubt that Einstein achieved novelty within the bounds of certainty.

Programmed learning may lead to a clearer establishing of these bounds, but it would be foolish to pretend that the technique does not contain the seeds of a threat to creativity, as do many presently used techniques in classrooms. A recent (January 1965) issue of *Programed Instruction* contains a discussion by Crutchfield and Covington which points out that programmed learning *can* lead to excessive uniformity, that it *can* allow insufficiently for individual patterns of thinking, that it *can* provide a minimum of creative stimulation, that it *can* be too intolerant of ambiguity and lack of closure in problem-solving. The authors having 'drawn the blackest possible picture of the case' go on to show how these dangers may be avoided, and how programmed materials can be used positively for creativity.

Programmers everywhere need to be fully aware of both sides of the argument.

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All developing countries have a great need for adequate medical facilities. These facilities include the obvious material ones such as hospitals, clinics and medicines, but most important are the doctors and the nursing staff.

In Africa there are very real problems in the training of medical staff, doctors, nurses and other aides. For the doctors, there may be insufficient information on rare diseases; the means for keeping up to date with research may be slight in the absence of regular courses for inservice medical education in most centres. For undergraduates in medical schools, it may sometimes be difficult to provide staff for the full range of courses needed.

To those who have the task of training nurses and aides, the whole range of problems based on cultural disadvantages presents itself. Inadequate grounding in simple arithmetic (used in making up solutions and compiling diets), poor scientific background (needed for many aspects of both theory and practice in the wards), lack of fluency in English (necessary usually to read the relevant texts and to understand the lecturers), and a sharp dichotomy between what is believed and what is learnt about the human body; all these make the training of nurses difficult in Africa.

Recent work in the University College of Rhodesia Medical School in Salisbury and in the Bulawayo hospitals has indicated that programmed learning may be able to assist in overcoming some of these problems. Both the first-year and the third-year medical students in Salisbury have taken small portions of their courses through programmed learning, with satisfactory results. In Bulawayo hospitals a programming group is now in existence, and a small number of experimental programmes have been written.

Programmes can teach. The evidence for this is now incontrovertible.

How well programmes teach is a different matter, and is the subject of widely varying experiments, many of them nearly valueless because they do not include adequate control of the numerous variables which are part of their design. The fact is, we shall never have the complete answer to the question of whether a particular programme (or even programmes in general) teaches better than a particular teacher (or even teachers in general).

This fact should not prevent us from considering theory which may help us to improve our programming. For instance, motivation is an aspect of teaching by programme which received all too little attention in the early days of programming. Programmers and experimenters, often trained as psychologists rather than as classroom teachers, seemed to think that provided they had a sequence of frames which yielded a low error rate and high post-test scores they were producing a good programme. High post-test scores can be obtained by over-cueing in the test, or by setting questions similar to those appearing in the programme. A low error rate can be obtained by multiplying the number of frames, so that much practice in examples which are fairly easy for the learner is provided. The end result of such procedures is a programme of too many frames for interest to be maintained.

Some experimenters also failed to notice that their results had been achieved with a few experimental groups unused to programmed learning. With such pupils the Hawthorne (or novelty) effect must have been great. Now a generation of pupils is coming along, particularly in some parts of America, which knows that programmes look like, and may actually be very bored by some marketed. Frame after frame which fails to smile at them or to issue any other reward than 90 per cent chance of success may be the cause of this. Pupils are not pigeons, as we have suggested before.

At the other end of the scale, however, we may find excessively 'chatty' programmes in which too much attention is consciously paid to motivation. In such programmes, pupils are told jokes, patted on the back verbally too often, and given verbose instruction about what to do next. These approaches only confuse the learner; the important becomes sunk deep in the trivial. The learner is slowed down too: he has to read so much more. In African schoools particularly, where low reading speeds are the rule, there is much to be said for what Rummler calls 'lean programming'. We need not go so far as to adopt Porter's blackout technique, by which *all* irrelevant information is deleted. There must be a balance somewhere: it is worth looking for.

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# CHAPTER THREE
# TECHNICAL REPORTS ON PROGRAMMES AND VALIDATIONS

### No. 1

## The Programme

*Title:* SIMPLE CONTOURS.

*Authors:* D. G. Hawkridge and W. D. Michie.

*Level:* Southern Rhodesia African Junior Certificate (i.e. Forms I and II in S. Rhodesia, which represent 'O'-level minus 4 and 3 years respectively). The pupils at this level have had at least eight years' formal schooling. Their age is about 14-15, although this will decline for later classes as the school-entry age declines.

*Type:* Modified linear. Two skipping sequences and one branching sequence vary the normal linear format.

*Form:* Booklet 5 in. x 8 in., with answers appearing on left-hand side of the succeeding page (no anti-cheat device). The text is typescript with many line drawings, printed by Rotaprint processes (off-print). Plasticine is provided with the programme for modelling purposes.

*Length:* The booklet has 32 pages of text, which offer 37 frames of varying length, requiring a total of 63 responses. If both skipping sequences are omitted through 100% correct answering of intermediate tests, only 47 responses are required.

*Criterion Behaviour:* After completing the programme, pupils are expected to be able to:

(a) define a contour;
(b) read the heights of contours;
(c) estimate the height of a point by referring to adjacent contours;
(d) shade in on a contour map land above or below a certain height;
(e) calculate the vertical interval (in the correct units) on a contour map;
(f) transfer simple three-dimensional forms, such as a hill, into approximate two-dimensional contours;
(g) read the direction of slope from contours.

## The First Validation

*The sample:* Two first-year classes at different African secondary schools* took part in the first validation:

Table 1. "Simple Contours" First Validation: sample

| | Boys | Girls | Total | Age Range | Age Mean | Previous Instruction |
|---|---|---|---|---|---|---|
| Class A .. .. | 32 | — | 32 | 12-16 | 14½ | Introduction to contours |
| Class B .. .. | 17 | 14 | 31 | 13-16 | 14½ | No previous instruction |
| A + B .. .. | 49 | 14 | 63 | | 14½ | |

*Administration:* Before receiving the programme booklet, each class was told the reason for the experiment, and the method of using the booklets was explained to them. A plasticine model of a hill was available for inspection in Class A, although no specific attention was drawn to it. In Class B, a model of a hill was shown to the class when it was discovered that the class's own models were in many cases unsuitable (this was an unexpected difficulty, caused perhaps by the remarkable configuration of certain granite outcrops near Salisbury).

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* The kind assistance offered by St. Ignatius and Goromonzi Schools is gratefully acknowledged.

Pupils filled in their responses in the booklets, thus expending them. Responses could have been recorded on separate answer pads.

*Time:* A rough check was made at intervals to assess what progress was being made through the programme:

Table 2. "Simple Contours" First Validation: times (minutes)

| Page | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|
| Class A .. .. | 12 | | 40 | | 55 | 70 |
| Class B .. .. | | 25 | | 47 | | 70 |
| Mean ? .. .. | 12 | 25 | 40 | 47 | 55 | 70 |

Time taken to complete the programme was carefully measured:

Table 3. "Simple Contours" First Validation: completion times (minutes)

| | First pupil | First six | Whole class |
|---|---|---|---|
| Class A .. .. | 50 | 60 | 75 |
| Class B .. .. | 52 | 63 | 75 |
| Mean ? .. .. | 51 | 62 | 75 |

It is interesting to note Class A's time: in spite of a slight previous knowledge of contours, they took as long as Class B, although the first to finish were a little quicker in Class A. It would seem reasonable to expect pupils familiar with such programmes to finish *Simple contours* in two normal 40-minute periods. Page 15 of the programme offers a convenient point at which to break off should no double period be available, although pupils might possibly find it more difficult to resume work after a day or more away from the programme.

*Use of skipping sequences:* Not all pupils realized that they could skip steps if they had scored 100% on the preceding intermediate tests. This was in spite of what appeared to the authors to be clear and adequate instructions. Apparently the idea of *not* reading the whole of a book was a novel one! More pupils would have finished sooner if these skipping sequences had been used properly. Table 4 gives the data.

Table 4. "Simple Contours" First Validation: use of skipping sequences

| | First sequence | | Second sequence | |
|---|---|---|---|---|
| | Eligible | Missed | Eligible | Missed |
| Class A .. .. | 32 | 23 | 19 | 8 |
| Class B .. .. | 29 | 19 | 18 | 3 |
| Totals .. .. | 61 | 42 | 37 | 11 |

*Error rates:* In computing error rates, it was deemed admissible to ignore errors made in answering the one multiple choice question. This may seem an unorthodox procedure, but this question (requiring pupils to shade in a map in a certain way, then compare it with three others to determine the pupils' subsequent route) was placed at a point in the programme where, by its form, it offered the programmers an opportunity to correct carefully any misapprehensions through two remedial loops. Two further frames followed and the efficacy of the short branching sequence was shown by the low error rate on these examples. Details of error rates follow in Table 5:

Table 5. "Simple Contours" First Validation: error rates

| | Average rate | Responses with + 10% e.r. | Error rate in last 10 responses |
|---|---|---|---|
| Class A .. .. | 7·1% | 14 | 6·9% |
| Class B .. .. | 8·2% | 16 | 9·0% |
| Mean .. .. | 7·7% | 15 | 8·0% |
| t .. .. .. | 0·30 | | Note: The last 10 responses are based on the criterion behaviour. |
| p .. .. .. | less than 1% | | |

These rates can be regarded as reasonably satisfactory for a first validation with a sample unaccustomed to programming. The difference between the classes is probably due to the slight previous instruction on contours given to Class A.

*Types of Errors:* An analysis (made during and after validation) of errors revealed seven types:

(1) Misunderstanding of method of using programmed books. This may be corrected by the use of a 6-page partially programmed booklet on how to use programmed books in the series planned. Trials with this booklet took place during the second validation of *Simple contours.*

(2) Misunderstanding of the questions. This mistake appeared to be rare, although not all pupils could express themselves adequately, whether in writing or drawing, in reply, e.g. pupils were unable to draw their models as they appeared from above.

(3) Conceptual difficulties. Some pupils did not understand the use of a double-headed arrow to indicate distance between two parallel lines. Others did not recognize at once a cross-sectional representation of a hill.

(4) Vocabulary was clearly a problem in some cases. Words like *imaginary, contour* and *vertical interval* needed most careful explanation.

(5) The transition from three-dimensional hills to their two-dimensional representation on a flat contour map proved difficult; both classes recorded high error rates (20% and 25%).

(6) The estimation of the height of a point by referring to adjacent contours revealed many errors in the initial steps; in the criterion test at the end, the rate dropped to below 10% in Class A, but was at about 23% in Class B.

(7) Lack of typographical or graphical clarity accounted for a few errors, to be corrected.

*Conclusion:* The first validation of this programme yielded much useful evidence concerning the learning problems of African pupils at the lower secondary stage.

### The Second Validation

*The sample:* Seven first year classes at various African secondary schools* took part in the second validation.

Table 6. "Simple Contours" Second Validation: sample

| | Boys | Girls | Total | Age Range | Age Mean | Previous Instruction |
|---|---|---|---|---|---|---|
| Class C .. .. | 31 | — | 31 | 13–17 | 15·4 | Nil |
| Class D .. .. | 31 | — | 31 | 13–17 | 14·6 | Nil |
| Class F .. .. | 23 | 8 | 31 | 13–17 | 14·6 | Nil |
| Class G .. | 25 | — | 25 | 14–20 | 15·7 | 1½ periods |
| Class H .. .. | 29 | — | 29 | 13–17 | 14·9 | 1½ periods |
| Class J .. .. | 18 | 9 | 27 | 14–17 | 14·5 | Nil |
| Class K .. .. | 20 | 8 | 28 | 13–16 | 14·6 | Nil |
| Totals .. .. | 177 | 25 | 202 | | | |

* The kind assistance offered by Mazoe, Highfield, Harare and Bernard Mizeki schools is gratefully acknowledged.

*Administration:* Each class was told the reason for the experiment, and the method of using the booklets. A plasticine model of a hill was on display to guide the pupils in making their own models. Pupils filled in their answers in the booklets.

*Time:* A rouch check was made to assess what progress was being made through the programme.

**Table 7. "Simple Contours" Second Validation: times (minutes)**

| Page | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|
| Class C .. .. | 8 | 18 | 26 | 30 | 40 | 52 |
| Class D .. .. | 5 | 15 | 24 | 33 | 40 | 55 |
| Class F .. .. | 9 | 19 | 27 | 34 | 42 | 61 |
| Class G .. .. | 8 | 18 | 30 | 36 | 41 | 50 |
| Class H .. .. | 10 | 21 | 27 | 32 | 40 | 45 |
| Class J .. .. | 10 | 20 | 30 | 35 | 50 | 60 |
| Class K .. .. | 10 | 18 | 28 | 33 | 42 | 50 |
| Mean ? .. .. | 9 | 18 | 27 | 33 | 42 | 53 |

The times taken to complete the whole programme were carefully measured:

**Table 8. "Simple Contours" Second Validation: completion times (minutes)**

|  | First pupil | First six | Whole class |
|---|---|---|---|
| Class C .. .. | 35 | 41 | 70 |
| Class D .. .. | 33 | 47 | 66 |
| Class F .. .. | 30 | 54 | 70 |
| Class G .. .. | 39 | 47 | 62 |
| Class H .. .. | 33 | 41 | 50 |
| Class J .. .. | 45 | 52 | 70 |
| Class K .. .. | 35 | 43 | 58 |
| Mean ? .. .. | 37 | 46 | 64 |

It will be noted that the time taken by the quickest pupil is usually about half that taken by the slowest. A double period (80 minutes) should be sufficient to administer pre-test, programme and post-test, when answers are written in the booklets.

*Attainment:* Two different tests were used as quantitative measures of attainment. With Classes F, G, and H, Test A was used. This proved to be unsatisfactory, as the questions were too easy, with the result that scores on pre-test were too high (see Table 9A). An amended test (Test B) was subsequently used, with considerable success (see Table 9B); in this test only one item proved to be too difficult, whilst two items were still rather too easy. The results obtained from Test B can be regarded as very satisfactory. The identical test was used for both pre-and post-test.

**Table 9. A. "Simple Contours" Second Validation: attainment (Test A)**

| Class | Pre-test | Post-test |
|---|---|---|
| Class F .. .. | 43·3% | 78·0% |
| Class G .. .. | 46·0% | 73·2% |
| Class H .. .. | 51·4% | 83·8% |
| Mean .. .. | 46·9% | 78·3% |

**Table 9 B. "Simple Contours Second" Validation: attainment (Test B)**

| Class | Pre-test | Post-test |
|---|---|---|
| Class C .. .. | 24·0% | 80·5% |
| Class D .. .. | 15·0% | 79·9% |
| Class J .. .. | 25·0% | 69·0% |
| Class K .. .. | 22·6% | 75·9% |
| Mean .. .. | 21·6% | 76·3% |

*Error rates:* Details of error rates follow in Table 10.

**Table 10. "Simple Contours" Second Validation: error rates**

| | Average rate | Responses with + 10% e.r. |
|---|---|---|
| Class C .. .. | 7·5% | 14 |
| Class D .. .. | 7·7% | 14 |
| Class F .. .. | 9·7% | 22 |
| Class G .. .. | 7·4% | 13 |
| Class H .. .. | 9·6% | 16 |
| Class J .. .. | 6·4% | 11 |
| Class K .. .. | 8·9% | 17 |
| Mean .. .. | 8·2% | 16 ex 62 |

*Use of skipping sequences:* In spite of clear initial instructions, between 15 and 65% of the pupils in each class who had scored 100% on the preceding intermediate tests failed to realize that this entitled them to skip pages. One pupil wrote down that he knew he *could* skip, but he did not want to! Table 11 gives details of the use of skipping sequences.

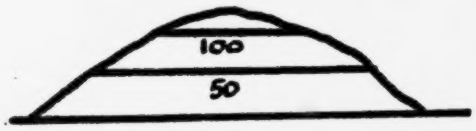
**Table 11. "Simple Contours" Second Validation: use of skipping sequences**

| | First skipping sequence | | Second skipping sequence | |
|---|---|---|---|---|
| | Eligible | Missed | Eligible | Missed |
| Class C .. .. | 22 | 10 | 16 | 5 |
| Class D .. .. | 22 | 11 | 17 | 7 |
| Class F .. .. | 18 | 11 | 21 | 12 |
| Class G .. .. | 25 | 11 | 12 | 2 |
| Class H .. .. | 22 | 15 | 15 | 6 |
| Class J .. .. | 21 | 10 | 17 | 8 |
| Totals .. .. | 146 | 74 | 113 | 47 |
| Not used .. | | 50·7% | | 41·6% |

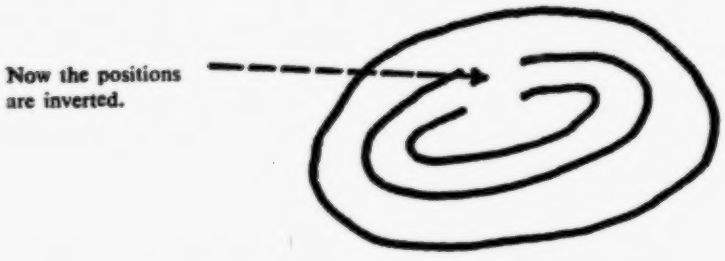
*Types of errors:* From the large (202) sample the points at which errors were still being made in this (revised) edition of the programme became very clear. Out of 1,038 errors made by the whole sample, just over half were made on only eleven responses. The points at which these occurred were:

(1) A request to a pupil to draw on paper what he could see from above when looking at his plasticine model of a hill. Most pupils could not draw what they could see.

(2) A request to the pupil to fill in on a sketch the heights of two contours. The question is more difficult than it looks because in the cross-section given, the heights appear thus:



whilst in the sketch the positions are inverted:



The mistakes were made when pupils failed to invert the figures.

(3) A fill-in question, requiring the completion of a definition: Contours join *places* at the same *height* above sea level. Pupils could not think of the correct word "places", apparently having been insufficiently cued.

(4) A simple contour map had three numbers on it: 1, 2 and 3; 1 was over 500 feet, the others lower. The question was which was highest. Thirty-seven pupils chose wrongly.

(5) The height of dots on simple contour maps had to be estimated. This proved too difficult, even within 5 ft. limits (50 ft. vertical interval), for about one-third of the sample, although they improved with practice.

(6) Land over, or under, certain altitudes had to be shaded on a map. For some unknown reason, pupils at one school found this particularly difficult.

*Conclusions:* No great difficulties were anticipated in the process of revision to eliminate errors 2-6 above, all of which were not due to conceptual difficulties. Error 1 represents a much more difficult case, but further experiment revealed a way to eliminate it.

In general the results showed that the programme *can* teach well almost all of what it claims to teach to the level of pupils for whom it is intended.

### The Third Validation

For the third validation (unsupervised field-trial) the following changes were made:

*Length:* The booklet was increased in length by two pages to 34 pages, which offer 34 frames of varying length, requiring a total of 74 responses. If both skipping sequences were omitted through 100% correct answering of intermediate tests, only 57 responses were now required.

*Format:* Page numbers were substituted for frames, since the 5 in. x 8 in. format allowed only one proper frame per page.

*Content:* The six difficulties mentioned in the Second Validation were dealt with thus:

(1) The difficulty of pupil's appreciating the side and top views of a hill (made of plasticine) was overcome by inserting a page requesting them to make an aeroplane of plasticine first, and to look at it sideways and from above. These two views are obviously different. The board used for modelling was included in the diagrams.

(2) Where heights of contours had been marked in erroneously, the pupils were now first asked to say which contour (A or B) was the higher.

(3) The word 'places' was given, instead of being requested.
(4) The clue '3 is over 300 feet' was included to make pupils think what height 1 and 2 might be over.
(5) Considerable practice (on an additional page) was provided in the estimation of heights from adjacent contours.
(6) No additional practice was offered in shading land over or under certain altitudes.

*The sample:* Four African secondary schools requested to be included in the unsupervised field trial (third validation). Eight classes were involved in the experiment, but the results from two classes were unusable because of a mistake made at the school concerned.

Table 12. "Simple Contours" Third Validation: sample

| | No. of pupils | Age | Previous Instruction |
|---|---|---|---|
| Class L* .. | 32 | 14½ | Some |
| Class M .. | 30 | 14½ | Some |
| Class O .. .. | 35 | 14½ | None |
| Class P .. .. | 33 | 14½ | None |
| Class Q .. .. | 35 | 14½ | Some? |
| Class R .. .. | 35 | 15 | Some? |
| Totals .. .. | 200 | 14½ | |

*Administration:* The schools received full instructions for the use of the booklets, and were asked to purchase plasticine for use with them. Plasticine models of the aeroplane and a hill were to be displayed at the teacher's desk. The usual pre-test/programme/post-test procedure was to be followed. Schools could please themselves about the expenditure of the books; answers could be written separately if desired.

*Time:* No page-by-page check on times was kept, but the following figures were received from one school:

| Pre-test | Programme | Post-test |
|---|---|---|
| up to 13 | 60-85 | 5-8 |
| | | (minutes required) |

*Attainment:* Attainment is the only quantitative measure of success in an unsupervised field trial. Table 13 gives details:

Table 13. "Simple Contours" Third Validation: attainment

| | Pre-test | Post-test |
|---|---|---|
| Class L .. .. | 38·1% | 81·3% |
| Class M .. | 33·3% | 74·0% |
| Class O .. .. | 32·0% | 83·4% |
| Class P .. .. | 25·8% | 73·6% |
| Class Q .. .. | 33·4% | 84·1% |
| Class R .. .. | 40·3% | 80·1% |
| Mean .. .. | 33·8% | 79·4% |

*Error rates:* In an unsupervised field trial, no error count is taken. The pupils retain the books.

*Types of error:* No mention was made by the pupils' teachers of points at which revision of the programme seemed to them to be desirable.

*Conclusions:* The overall results, particularly those relating to attainment, indicated that this programme had completed its unsupervised field trial with some success. Further refinements remained to be carried out before final validation.

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*The kind assistance given by Gloag, St. Anne's, Harare and Solusi is gratefully acknowledged.

## No. 2

### The Programme

*Title:* MAP SCALES.

*Authors:* D. G. Hawkridge and W. D. Michie.

*Level:* Southern Rhodesia African Junior Certificate (i.e. Forms I and II in S. Rhodesia, which represent 'O'-level minus 4 and 3 years respectively). The pupils at this level have had at least eight years formal schooling. Their age is about 14-15, although this will decline for later classes as the school-entry age declines.

*Type:* Linear. No skipping sequences.

*Form:* Booklet 5 in. x 8 in., with answers appearing on left-hand side of the succeeding page (no anti-cheat device). The text is in typescript with a number of line drawings. Reproduced by Rotaprint processes (off-print). A ruler was provided with the programme.

*Length:* The booklet has 23 pages of text, offering 28 frames of varying length, requiring a total of 62 responses.

*Criterion behaviour:* After completing the programme, pupils are expected to be able to:

(a) appreciate the use of scale to reduce objects to drawable proportions;
(b) state a simple definition of map scale;
(c) state the scale of a map, e.g. "Two inches to one mile" (a Statement of scale);
(d) state the scale of a map as a Representative Fraction;
(e) convert simple Statements of scale to Representative Fractions;
(f) draw simple scale diagrams;
(g) use simple scale diagrams to measure distance on a map;
(h) recognize that an R.F. of 1 : 63360 indicates a scale of one inch to one mile.

### The First Validation

*The sample:* Three first-year classes at two different African secondary schools* took part in the first validation:

Table 14. "Map Scales" First Validation: sample

| | Boys | Girls | Total | Age Range | Age Mean | Previous Instruction |
|---|---|---|---|---|---|---|
| Class C .. .. | 28 | — | 28 | 13–16 | 14½ | Nil |
| Class D .. .. | 29 | — | 29 | 13–17 | 14½ | Nil |
| Class E .. .. | 15 | 11 | 26 | 13–16 | 14½ | Nil |
| C + D + E | 72 | 11 | 83 | | 14½ | |

*Administration:* Each class was told the reason for the experiment, and the method of using the booklets was explained to them. In an attempt to reduce errors due to any misunderstanding of the system of using the booklets, the pupils in Classes C and D used first as introduction a booklet entitled *How to Learn Step by Step* which taught them how to use programmes of the type described here. (The use of this booklet is described under Technical Report No. 3 in the *Information Bulletin.*) Class E already had experience of programmes, having taken part in the first validation of *Simple Contours*. Pupils filled in their answers in the booklets, thus expending them. Responses could have been recorded on separate answer sheets, although the question does then arise whether the learning would have been as efficient.

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*The kind assistance offered by Goromonzi and Mazoe Schools is gratefully acknowledged.

*Time:* A rough check was made at intervals to assess what progress was being made through the programme (times in minutes):

**Table 15. "Map Scales" First Validation: times (minutes)**

| Page | 5 | 10 | 15 | 20 |
|---|---|---|---|---|
| Class C .. .. | 11 | 16 | 22 | 44 |
| Class D .. .. | 10 | 15 | 25 | 35 |
| Class E .. .. | 9 | 13 | 20 | 30 |
| Mean ? .. .. | 10 | 15 | 23 | 36 |

The times taken to complete the programme were carefully measured:

**Table 16. "Map Scales" First Validation: completion times (minutes)**

| | First pupil | First six | Whole class |
|---|---|---|---|
| Class C .. .. | 39 | 54 | 63 |
| Class D .. .. | 40 | 45 | 70 |
| Class E .. .. | 30 | 40 | 52 |
| Mean ? .. .. | 36 | 46 | 63 |

*Error rates:* Details of error rates follow in Table 17.

**Table 17. "Map Scales" First Validation: error rates**

| | Average rate | Responses with +10% e.r. |
|---|---|---|
| Class C .. .. | 16·1% | 27 |
| Class D .. .. | 13·6% | 23 |
| Class E .. .. | 10·2% | 16 |
| Mean .. .. | 13·6% | 22 |

These error rates are too high to be considered satisfactory, indicating the need for a thorough revision of the programme before its second validation. The topic proved a difficult one to programme, particularly the section dealing with Representative Fractions.

*Types of Errors:*

(1) Very few pupils appeared to misunderstand how to use the booklets. This source of error can be said to have been eliminated as far as it can be.

(2) It proved difficult to indicate clearly in the programme the positions where answers were to be written in the cases where fractions (e.g. Representative Fractions) had to be completed. The capacities of Rotaprint, in one colour, do not provide for adequate 'coding' of instructions. It is interesting to note that Methuen's Clearway Texts in mathematics have made good use of two-colour printing in this connection.

(3) The progression from $\frac{\text{1 inch}}{\text{1 mile}}$ to $\frac{1}{63360}$ proved difficult for the learners. Having approached Representative Fractions from the definition "Map scale is the *relation* between distance on the map and distance on the ground", the programme had then to explain that in the Representative Fraction one did *not* write $\frac{\text{1 inch}}{\text{1 mile}}$, and that $\frac{1}{63360}$ could mean $\frac{\text{1 metre}}{\text{63360 metres}}$.

(4) Having explained $\frac{1}{63360}$ as a Representative Fraction, the programme continued by showing that $\frac{1\text{ inch}}{2\text{ miles}}$ could be worked out as $\frac{1}{126720}$, and $\frac{1\text{ inch}}{3\text{ miles}}$ as $\frac{1}{190080}$. Few pupils managed the latter on their own.

(5) A prompt of the informal or shadow kind ("Remember that 1 mile is 63360 inches") induced responses stated as an R.F. instead of as a Statement of scale.

(6) A transfer from inches and miles to centimetres and kilometres proved too difficult for most of the pupils (possibly on account of a poor background in arithmetic).

(7) The scale diagram was used incorrectly by a good number of pupils to measure distance on a map.

(8) The fractioned section of the scale diagram could be used by most pupils, but the programme failed to teach them how to draw one to a certain scale.

*Conclusion:* Again, the first validation of a programme yielded much useful information concerning the learning problems of African pupils at the lower secondary stage. No pre-test or post-test was used at this point to measure learning.

### The Second Validation

The fourth edition (for the second validation) contained many minor changes, more pages (31 instead of 23), and more responses (136 instead of 123), for the same criterion behaviour.

*The sample:* Three first year and two third year classes at two African secondary schools* took part in the second validation.

Table 18. "Map Scales" Second Validation: sample

|  | Boys | Girls | Total | Age-range | Previous Instruction | Year |
|---|---|---|---|---|---|---|
| Class S .. .. | 22 | 7 | 29 | 15–20 | Some | 3 |
| Class T .. .. | 23 | 7 | 30 | 15–20 | Some | 3 |
| Class U .. .. | 21 | 10 | 31 | 13–17 | None | 1 |
| Class V .. .. | 21 | 10 | 31 | 13–17 | None | 1 |
| Class W .. | 29 | 0 | 29 | 13–18 | None | 1 |
| Totals .. .. | 116 | 34 | 150 |  |  |  |

*Administration:* Each class was told the reason for the experiment, and the method of using the booklets. Pupils filled in their answers in the booklets.

*Times:* The times taken to complete the programme were carefully measured.

Table 19. "Map Scales" Second Validation: time (minutes)

|  | First Pupil | First Six | Whole Class |
|---|---|---|---|
| Class S .. .. | 45 | 50 | 75 |
| Class T .. .. | 55 | 61 | 95 |
| Class U .. .. | 47 | 53 | 82 |
| Class V .. .. | 45 | 57 | 85 |
| Class W .. | 60 | 73 | 102 |
| Mean ? .. .. | 50 | 59 | 88 |

Class W was very weak (tenth stream) and took far longer than the others.

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* The kind assistance offered by Goromonzi and Bulawayo secondary schools is gratefully acknowledged.

*Attainment:* No test was used in the first validation. The one used here needs revision in one or two questions on item-analysis, but may be regarded as a good test of the attainment of the criterion behaviour.

**Table 20. "Map Scales" Second Validation: attainment**

|  | Pre-test | Post-test |
|---|---|---|
| Class S .. .. | 35·0% | 68·7% |
| Class T .. .. | 32·5% | 57·3% |
| Class U .. .. | 8·1% | 44·8% |
| Class V .. .. | 5·4% | 40·8% |
| Class W .. | 8·8% | 32·0% |
| Mean .. .. | 18·0% | 48·7% |

Bearing in mind that classes S and T are third year forms, the results could not be said to be satisfactory. It was surprising that these two classes did not achieve even better results on both pre- and post-test. The latter might be explained by the inherent complexity of the programme.

*Error rates:* Details of error-rates follow in Table 21.

**Table 21. "Map Scales" Second Validation: error-rates**

| Class | S | T | U | V | W | Mean |
|---|---|---|---|---|---|---|
| Error-rate .. | 8·3 | 7·0 | 14·1 | 12·3 | 13·4 | 10·8 |

*Conclusions:* A comparison between Tables 20 and 21 reveals that classes with lower error-rates did not necessarily score well on the attainment test. Since the programme was not cheat-proof, it is likely that the error-rates were higher, in reality, than shown in Table 21. The rate was, in any case, too high to be acceptable. The programme needed to be re-written from a different approach.

## No. 3

### The Programme

*Title:* PROGRAMMED LEARNING: A LAYMAN'S INTRODUCTION.

*Author:* D. G. Hawkridge.

*Level:* For adults with G.C.E. 'O' level or its equivalent (i.e. about eleven years' schooling). All English-speaking nationalities.

*Type:* Modified linear, with six remedial loops.

*Form:* Quarto booklet, vertical format, about five frames to the page, with answers appearing on the left-hand side of the following frame. No anti-cheat device, but programme to be used with masking card. Roneoed typescript. No practical work required. Pre-test/post-test provided.

*Length:* 21 pages of text contain 100 frames of varying length, requiring a total of 170 responses.

*Criterion behaviour:* After completing the programme, students should be able to:

(a) define programmed learning;
(b) state its field of origin;
(c) state the effect upon learning of knowledge of results;
(d) use correctly the technical terms "reinforcement" and "conditioning."
(e) appreciate the value (if any) of pupils' cheating;
(f) state the effect upon learning of pupil participation;
(g) name correctly the two main types of programme, and state three characteristics of each;
(h) draw a simple diagram to illustrate the structure of the two main types of programme;
(i) offer alternative names for the two main types of programme;

(j) offer two alternative names for cues;
(k) list four ways in which cues may be offered;
(l) use correctly the technical term "fading";
(m) state correctly and in order the first steps in preparing to write a programme;
(n) specify the purpose of a pre-test;
(o) use correctly the technical term "conversational chaining";
(p) diagnose causes of poor pre-test or post-test scores, in simple fashion;
(q) state programme objectives in terms of the learner;
(r) appreciate that, having read this book, they are not yet ready to start programme writing.

### The First Validation

*The sample:* Two groups took part in the first validation. The first (A) consisted of training officers of various branches of the copper mining industry of Zambia. Their educational level varied from the minimum stated above to graduates. One or two had previous acquaintance with books on programmed learning. The second group (B) consisted of Rhodesian teacher training college lecturers, all of whom possessed professional qualifications for teaching and about one-third of whom held degrees. Several had previous acquaintance with programming.

*Administration:* The simple pattern of pre-test/programme/post-test was followed. Instructions for using the programme were contained in the booklet. Group A read the programme as part of a 3-day seminar designed to train the participants in experimental programme writing for industry. Group B read the programme as the basis for a discussion session, the whole time spent on programmed learning amounting to 2½ hours during a week-long conference on matters educational.

*Time:* Only a rough check on times was feasible in either group. The pre-test took about 10 minutes to complete, the post-test rather less. The programme itself was finished in half an hour by some; others took over an hour.

*Attainment:* The pre-test and post-test were identical, consisting of 27 questions requiring 49 responses.

**Table 22. "Programmed Learning" First Validation: attainment**

| | Pre-test | | Post-test | |
|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. |
| Group A .. (N = 16) | 23·5% | 13·8 | 81·1% | 13·5 |
| Group B .. (N = 17) | 24·4% | 15·1 | 82·5% | 14·3 |
| Total .. .. (N = 33) | 23·5% | 14·5 | 81·8% | 13·9 |

*Error rates:* Details of error rates follow in Table 23.

**Table 23. "Programmed Learning" First Validation: error rates**

| | Average rate | Responses with +10% e.r. |
|---|---|---|
| Group A .. | 4·8% | 28 |
| Group B .. | 2·8% | 15 |
| Mean .. .. | 3·8% | 22 |

*Types of errors:* Almost all the errors made in the first validation could be attributed to either (a) inattention on the part of the student (e.g., "is X more or less likely now?" Answer offered: "No") or (b) ambiguous and vague questioning on the part of the author. The error rate should drop slightly with the revised edition. It might also be thought, however, that the low error rate indicated that the programme was too easy. Neither group appeared to feel that it was so, and several participants said afterwards that they had been compelled to concentrate and think to a great extent.

*Conclusions:* In view of the low error rate, it would be interesting to try this programme on a less mature sample of adults—say training college students. Otherwise, within the limitations of an introductory programme such as this one, the author's objectives appear to have been nearly achieved. The reasonably low pre-test scores indicated a general lack of knowledge about programmed learning, even amongst training college lecturers, and the good post-test scores showed that the material had been understood.

## No. 4

### The Programme

*Title:* INTRODUCTION TO INDICES.

*Authors:* R. Hicks and D. G. Hawkridge.

*Level:* Zambian or Rhodesian African Junior Certificate (i.e. Form I in both countries, which represents 'O' level minus 4 years). The pupils at this age have at least seven years' formal schooling. Their age is 11 to 15, the wide range being accounted for by variations in entry-age to the primary school as well as the length of primary schooling.

*Type:* Linear, although more than one response is required in many frames.

*Form:* Booklet approx. 4 in. x 8 in. with answers appearing on left-hand side of the succeeding page. (No anti-cheat device.) Typescript, roneoed.

*Length:* The booklet has 26 pages of text, offering 26 frames of varying length, requiring a total of 117 responses.

*Criterion Behaviour:* The programme is meant to be one of a series which will lead the pupil to an understanding of indices and the ability to manipulate indices. For this programme, a background in manipulation and division is essential, and some knowledge of factorization (factors of 6 are 3 and 2), and first steps in algebra (the use of letters as though they were numbers) may also be helpful, but factors are explained in the programme and the algebra in it flows naturally from the arithmetic.

After completing the programme the pupils should be able to deal with the following:

(a) the meaning of the index;
(b) $a.a.a. = a^3$
(c) $a^2.a^4.a^6. = a^{12}$
(d) $a^2.a^4.b^4.b = a^6.b^5$

and similar examples.

Tests are used in this programme, including two pre-tests and a post-test.

### The First Validation

*The sample:* Three first year classes at one African secondary school* took part in the first validation. Table 24 indicates the constitution of the sample:

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* The kind assistance offered by Harare School is gratefully acknowledged.

Table 24. "Introduction to Indices" First Validation: sample

| | Boys | Girls | Total | Age Range | Age Mean | Previous Instruction |
|---|---|---|---|---|---|---|
| Class L .. .. | 20 | 11 | 31 | 13–17 | 14½ | Nil |
| Class M .. | 20 | 10 | 30 | 13–16 | 14½ | Nil |
| Class N .. .. | 20 | 11 | 31 | 13–16 | 14½ | Nil |
| L + M + N | 60 | 32 | 92 | | | |

*Administration:* Each class was told the reason for the experiment, and the method of using the booklets was explained to them. It should be noted that the classes were told in what way cheating would place them at a disadvantage, and in two classes a careful watch was kept for cheating. These points bear on a later comment under the heading *cheating* below.

Pupils filled in their answers in the booklets, thus expending them.

*Time:* A rough check was made at intervals to assess what progress was being made through the programme.

Table 25. "Introduction to Indices" First Validation: times (minutes)

| Page | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|
| Class L .. .. | 5 | 15 | 23 | 35 | 50 |
| Class M .. | 6 | 14 | 20 | 30 | 47 |
| Class N .. .. | 5 | 17 | 21 | 30 | 51 |
| Mean .. .. | 5 | 15 | 21 | 32 | 49 |

The times taken to complete the programme were carefully measured:

Table 26. "Introduction to Indices" First Validation: completion times

| | First Pupil | First Six | Whole Class |
|---|---|---|---|
| Class L .. .. | 40 | 48 | 65 |
| Class M .. | 50 | 52 | 65 |
| Class N .. .. | 35 | 50 | 60 |
| Mean .. .. | 42 | 50 | 63 |

*Attainment:* The pre-test and post-test were identical, being in two parts, A and B. Part A dealt with material pupils were *expected* to know before using the programme; Part B tested what was taught by the programme. On Part A all three classes scored over 95%, errors being attributable mainly to carelessness. The results for Part B are shown in Table 27.

Table 27. "Introduction to Indices" First Validation: attainment

| | Pre-Test | Post-Test |
|---|---|---|
| Class L .. .. | 14·7% | 89·5% |
| Class M .. | 6·5% | 60·5% |
| Class N .. .. | 12·5% | 69·5% |
| Mean .. .. | 11·2% | 73·2% |

The reasonably high post-test scores, together with the overall increment in attainment, might appear to indicate satisfactory progress in spite of the high error rates quoted in Table 28, and in spite of the cheating rate in Table 29 below. Analysis of the test items revealed an undesirably high proportion which were precisely repeated frames of the programme itself. It is necessary to revise these items for the second validation in order to discover whether there has been satisfactory understanding of the principles taught, leading to good transfer of learning. It should also be noted that the post-test scores shown in Table 27 were achieved in spite of the fact that in Class M only 40% of the pupils answered *all* items in the test. (Class L 57% and Class N 61%.)

*Error Rates:* Details of error rates are given in Table 28.

**Table 28. "Introduction to Indices" First Validation: error rates**

| | Average Rate | Responses with + 10% e.r. |
|---|---|---|
| Class L .. .. | 10·0% | 41 |
| Class M .. | 10·6% | 37 |
| Class N .. .. | 14·0% | 53 |
| Mean .. .. | 11·5% | 44 ex 117 |

These error rates were too high to be considered satisfactory, particularly in the light of the cheating rate as estimated below. Several sections of the programme need thorough revision.

*Cheating rate:* By reason of two printing errors in the answers the cheating rate could be estimated for the three classes, although Class N was warned to look out for two errors (but not told where they were). This rate may only be estimated, as it is just possible that some pupils genuinely wrote down the wrong answers thinking they were right before turning over. The blatancy of the errors makes this unlikely, however, particularly at page 13.

**Table 29. "Introduction to Indices" First Validation: cheating rates**

| Page | 13 | 14 | Mean |
|---|---|---|---|
| Class L .. .. | 41·9% | 22·6% | 32·3% |
| Class M .. | 43·3% | 86·7% | 65·0% |
| Class N .. .. | 30·0% | 87·1% | 58·6% |
| Mean .. .. | 41·7% | 65·5% | |

This high cheating rate (estimated) can be accounted for partly in terms of over-motivation (the desire to do well and not make mistakes), but also in terms of the difficulty of the programme. If an anti-cheat device had been used it is probable that post-test scores would be higher too. To some extent this validation has lent support to the programmers' belief that pupils who cheat do still learn significantly! In a more carefully graded programme it is likely that less cheating would be done. The rate shows a tendency to increase with decreasing ability (classes L, M and N are in decreasing order of ability), although the warning to Class N apparently had some effect.

*Conclusions:* The second validation could be expected to yield a reasonably good programme producing sub-10% error rates and 75% plus post-test scores.

## No. 5

### The Programme

*Title:* NOUN CLAUSES AND PHRASES.

*Authors:* Pamela Pearce and John Sutton-Smith.

*Level:* For Zambian or Rhodesian African Junior Certificate. (Form I in both countries.) Also suitable for Europeans in first years at secondary school.

*Type:* Pure linear, although more than one response is required in some frames.

*Form:* Booklet. Approx. 4 in. by 8 in., with answers appearing on left hand side of succeeding page. (No anti-cheat device.) Typescript. Roneoed.

*Length:* The book has 21 pages of text, offering 21 frames of varying length, requiring 38 responses.

*Criterion Behaviour:* After completing this programme, the pupils should be able to recognize, and analyze the function of noun clauses and phrases in a sentence. They should also be able to compose an example for themselves.

**The First Validation**

*The sample:* One first year class (Form IB) of 34 pupils at an African secondary school took part in the first validation.

*Administration:* The class was told the reason for the experiment, and the method of using the booklet was explained to them. Pupils were told that cheating would be to their disadvantage. Pupils filled in their answers in the booklets, thus expending them.

*Time:* They had one hour and twenty minutes in which to do pre-test, programme and post-test. All finished in this time. Pupils progressed at their own rate; no time check for each section was kept.

*Attainment:* The pre-test and post-test were identical, being in three parts. Section A dealt with material pupils were expected to know before using the programme (pre-requisite behaviour). Section B tested what was taught by the programme (criterion behaviour).

Table 30. "Noun Clauses and Phrases" First Validation: attainment

| | Pre-test | Post-test |
|---|---|---|
| Section A .. | 85% | 90% |
| Section B .. | 33% | 67% |

*Error rate:* The overall error rate in the programme was 3%. 1.5% of this rate may be accounted for by one frame, which demanded nine responses, and should obviously be broken down into smaller steps in the revised version.

Many of the remaining errors were due to carelessness or omissions.

The error rate was probably lowered by a fair amount of cheating in several cases.

*Conclusions:*

(1) The pre-test scores indicated that the pupils had some confused knowledge of noun clause analysis before they started the programme.

(2) Ten pupils failed to improve their scores. None of the ten made more than two mistakes in doing the programme, which seemed to indicate that they might have cheated.

(3) It is acknowledged that several improvements and a second validation are necessary before it can be claimed that the programme fully achieves its object.

## No. 6

**The Programme**

*Title:* THE 1802 FACTORY REFORM ACT.

*Author:* C. H. Bickerton.

*Level:* For average or above average pupils in Forms III and IV in African secondary schools. It would probably be quite suitable, however, for the same levels in European schools.

*Type:* Linear.

*Form:* Booklet, 8 in. by 4 in.; 26 pages. Answers appear on left hand side of page following question. No anti-cheat device. Typescript, roneoed. Pre/post-test provided.

*Length:* Twenty-two frames of varying length, containing a total of 95 responses. Range of responses per frame, 1-12.

*Criterion Behaviour:* After using this programme, pupils should be able to:

(a) state conditions leading to the introduction of the act;

(b) state the terms of the act;

(c) state how it was to be enforced;

(d) state the reasons for its failure;
(e) state the long term consequences of the act.
No previous historical knowledge is assumed.

### The First Validation

*The sample:* Forms III and IV at an African secondary school*, including 48 pupils in all.

*Administration:* The classes were told the reason for the experiment and the method of using the booklet. The pupils worked through the booklet filling in the answers, with a minimum of assistance from the administrators. Only where a mechanical mistake was likely to be made was guidance volunteered. However, *all* pupils' questions were answered fully. These referred mainly to printing errors.

*Time:* Two periods (80 minutes) were allotted. Form IV completed the programme (including tests) well within the limit. Some members of Form III required an extra 10 minutes, mainly because Form III spent much longer in attempting the pre-test. The time taken on working through the programme was approximately the same as for Form IV (i.e. 60 minutes).

*Attainment:* The same test was given before and after working through the booklet. Results were as follows:

**Table 31. The 1802 Factory Reform Act First Validation: attainment**

| | Pre-test | | Post-test | |
|---|---|---|---|---|
| Form 3 .. .. | Mean 6% | S.D. 3·9 | Mean 87% | S.D. 12·96 |
| Form 4 .. .. | Mean 22% | S.D. 11·3 | Mean 84% | S.D. 12·3 |

*Error rate:* The overall error rate for both classes was 2.2%. Three responses had a greater than 10% error rate.

*Types of errors:* Four main types of response were required:

(1) Response(s) to questions based on a short paragraph of instructional material.
(2) Filling in word(s) left out of passage of text.
(3) Choosing a response from three possible answers.
(4) Response(s) to questions relating to previous frame(s).

The three responses which had a high error rate were divided between types (1), (3) and (4).

Page 20 in the programme represents type (1), in which pupils were required to read a passage of text and decide how employers could avoid complying with the act from the facts given. This had the highest error rate in the programme. A branching frame could rectify this.

Page 15 represents type (3). Here the high error rate might be reduced by giving the pupils more assistance in the preceding text.

Page 10 represents type (4). The mistakes here were due to ambiguity in the question.

*Conclusions:* Although the first validation was carried out with a relatively small sample, the results were encouraging.

## No. 7

### The Programme

*Title:* Roots and Surds.

*Author:* W. R. Read, with initial assistance from J. B. Flatt.

*Level:* For academic-stream Form III classes in African secondary schools.

* The kind assistance of Harare School is gratefully acknowledged.

*Type:* Linear.

*Form:* One-third foolscap booklet, with one frame per page. Answers to responses on left hand side of next page. Typed with the use of a special mathematics keyboard. Pre- and post-test separate: an intermediate test included. Revision section at the end. Roneoed.

*Length:* Thirty-seven pages containing about 50 responses, including words and numerical examples. Responses divided into 38 groups for validation.

*Criterion Behaviour:* After completing this programme, pupils should be able to:

(a) distinguish between rational numbers, irrational numbers and surds;
(b) apply the basic algebraic laws in the manipulation of expressions involving roots;
(c) apply the special technique of rationalizing the denominator.

**The First Validation**

*The sample:* A third form at an African secondary school*; 20 boys, nine girls.

*Administration:* The purpose and use of the programme was explained, plus some advice and comments on cheating. Individual problems arising during the course of the programme were dealt with individually. The only assistance given to the class as a whole was where layout of examples caused confusion.

*Time:* The time allowed for the whole experiment was two double and one single periods, spread out over three weeks. Time taken by the fastest pupil over the actual programme was 2 hours. A few unfortunately did not finish the post-test, on account of lack of time.

*Attainment:*

| Pre-test | Post-test |
|---|---|
| Mean 19.9% | Mean 68.3% |
| Range 0-33% | Range 42-87% |

*Error rate:* Mean error rate on programme: 16%, range 0-80%. Responses with plus 10% error rate: 19 out of 38.

*Types of errors:* All those responses with greater than 10% error rate were numerical examples. The actual errors are too numerous to list, but in general they were due to:—

(a) Teaching faults—insufficient information, method of approach, and underestimation of difficulties.
(b) Insufficient examples at each step: too fast a pace.
(c) Layout of the printed page: tended to inhibit individual approach.
(d) Difficulty of presenting a worked example—step-by-step demonstration is not easily possible.
(e) Differences in conventions: e.g. 'a.b' meaning 'a' times 'b'; order of multiplication of brackets.

A revised test was also shown to be necessary; some examples were very much harder than those in the programme.

*Conclusions:* The error rates showed a need for considerable revision both in the test and the programme, although the post-test results showed that some learning had taken place.

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* The kind assistance of Goromonzi School is gratefully acknowledged.

## No. 8

### The Programme

*Title:* TOWN AND COUNTRY.

*Author:* J. D. Jordan.

*Level:* Adults with at least eight years' primary schooling. As will be seen from the validation data, experiments have been carried out with several categories of persons having the basic qualification.

*Type:* Linear with two branching sequences.

*Form:* One-third foolscap booklet, with one frame to a page and the answer appearing on the left of the succeeding page. No anti-cheat provision.

*Length:* The 50-page booklet contains 47 frames requiring 67 responses.

*Criterion Behaviour:* After completing the programme the learner should be able to explain the economic relationship between town and country in a developing country (Rhodesia) and the economic effects of a rapidly expanding population.

### The First Validation

*The sample:* Twenty-eight students at a teacher training college with at least ten years of formal education.

*Administration:* A pre-test was given, then a number of the background facts about Rhodesia and Rhodesia's population were drawn out in discussion and put up on a flannelgraph. It should be noted that the programme was thus integrated with more conventional teaching techniques, and the post-test scores cannot be attributed to the programme alone.

The way to use the programme was then explained. After completing the programme, the pupils completed a post-test which was identical to the pre-test.

*Time:* The time was not recorded, but was approximately one hour for the programme.

*Attainment:*

Table 32. "Town and Country" First Validation: attainment

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 41% | 72% |

*Error-rate:* Eighteen frames yielded an error rate of more than 10%, indicating the need for some revision.

### The Second Validation

*The sample:* Twenty-seven primary school teachers participating in a teachers' conservation course. All had at least ten years of formal education.

*Administration:* The same procedure was followed as in the first validation.

*Time:* The time was not recorded at all.

*Attainment:*

Table 33. "Town and Country" Second Validation: attainment

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 32% | 75% |

*Error rate:* Seven frames yielded an error rate of more than 10%, indicating the need for some revision.

### The Third Validation

*The sample:* Twenty-four agricultural extension assistants, all having at least eight years of primary schooling.

*Administration:* The same procedure was followed as in the other two validations.

*Time:* Times taken by the assistants to complete the programme were taken; the range was 26-64 minutes.

*Attainment:*

**Table 34. "Town and Country" Third Validation: attainment**

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 36% | 72% |

*Error rates:* The mean error rate for all learners in this grop was 6.5%. Five frames yielded an error rate of more than 10%.

*Cheating:* It is known that two participants in the third validation cheated considerably. It is interesting to compare their scores:

**Table 35. "Town and Country" Third Validation: scores of two cheaters**

| | Pre-test | Post-test |
|---|---|---|
| A .. .. .. .. | 20% | 100% |
| B .. .. .. .. | 50% | 60% |

The only comment that may be offered here is that no pattern is likely to be detected amongst the scores of cheaters, since they cheat for different reasons and with differing efficiency!

*Conclusions:* One of the purposes of developing this programme was to allow participants to examine objectively a subject which is frequently misunderstood and which tends to arouse emotional rather than rational responses. In fact, a discussion still seems to be a better method of teaching for this topic. The reason for this is that after a discussion, even one which has been fairly tightly controlled and structured, participants tend to feel that the conclusions reached are their own, whilst after the programme they tend to consider the conclusions to have been foisted upon them. A discussion seems to be a better attitude changer than a programme. Thus, although the post-test scores are satisfactory, this programme is to be abandoned in its present form. A new version is to be written which will attempt to present generalizations as a basis for a discussion which will follow the programme and will deal specifically with the problems discussed and taught in it.

## No. 9

### The Programme

*Title:* GRADES.

*Author:* J. D. Jordan.

*Level:* Agricultural extension assistants with at least eight years' primary schooling.

*Type:* Linear.

*Form:* The quarto booklet contained five frames to a page (126 frames in all). Answers were given on the left of the succeeding frame. No anti-cheat provision, but a card was used to cover the next frame. Answers were to be written on a separate sheet.

*Length:* The 126 frames required a total of 210 responses, many of them numerical.

*Criterion Behaviour:* After completing the programme the learner should be able to:

(a) define a grade (gradient);
(b) recognize equivalent grades;

(c) calculate rises for differing horizontal distances and grades;
(d) recognize equivalent grades when expressed in different units of measurement;
(e) calculate the length of a contour ridge (graded terrace).

In other words, the learner will be able to deal with the arithmetic problems which arise when pegging contour ridges.

### The First Validation

*The sample:* An intake of recruits was tested for knowledge of areas, grades and triangles. Six required further training in areas, and were set to study the programme *Areas of Rectangles* by Roy Harris (Methuen, 1964). One did not require instruction on grades. Thirty-eight worked through the grades programme in its first validation.

*Administration:* In the first session the working of the programme was explained. Participants were told to call for help if required, and to note frames which they answered wrongly. The latter instruction did not need to be repeated in later sessions because it was found that the revision frames, incorporated in the programme, automatically drew the experimenter's attention to deficient frames when participants called for help. The pre- and post-tests were identical.

*Time:* Time needed to complete the programme varied from 2 hours 45 minutes to 5 hours 30 minutes. The pre- and post-tests (about half an hour each) were handled in separate periods.

*Attainment:*

**Table 36. "Grades" First Validation: attainment**

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 32·9% | 67·3% |
| Range .. .. | 15–65% | 20–80% |

The attainment scores in the first validation may be compared with those obtained by a similar but not equated group pursiung a non-programmed version of the same course.

**Table 37. "Grades" (Non-programmed course): attainment**

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 36·4% | 48·6% |
| Range .. .. | 15–75% | 35–75% |

Both groups showed a tendency on pre-test to confuse units of measurement. The same tendency was apparent in a few post-tests. Analysis of the post-test items showed that the programme had not taught one essential part of the definition of a grade, nor the solution of problems of total rise along a given distance.

*Types of error:* Apart from the errors disclosed by the post-test, others were discovered through an error analysis of the frames of the programme. Three main types of errors were found:

(a) *Mistakes due to inadequate instructions:* For instance, in frame 24 an instruction to use the ruler on the horizontal not the sloping line, needs to be added. In frame 32, directing lines need to be added to show the mechanics of the calculation required.
(b) *Mistakes due to inadequate explanation of incorrect or correct answers:* Sometimes merely to give the correct answer is not sufficient to help the pupil to understand why the answer he has given is right or wrong. In

other words, some teaching can be done in the answer column, where convenient and necessary.

(c) *Mistakes due to misunderstanding of terms used:* The word 'product' was not understood at all well, therefore the general rule of which the word formed a part was not properly understood.

*Conclusions:* The experimenter felt that the post-test means could have been better, and intends to revise the programme to teach better certain points:

(a) the definition of a grade;
(b) the need to differentiate between the use of yards and the use of feet in some cases;
(c) the concept of total rise.

## No. 10

### The Programme

*Title:* HOW PEOPLE LEARN.

*Author:* J. D. Jordan.

*Level:* Adults with at least eight years' primary schooling who intend to become teachers or trainers.

*Type:* Linear.

*Form:* The foolscap booklet contained seven frames to a page (97 frames in all). It was contained in a cardboard 'machine' box, with windows to reveal the teaching area of each frame and an answer space where the student wrote his answer. The correct answer was concealed until the programme had been pulled on, which action placed the student's answer where he could not easily change it. The system was not cheat-proof, however, since the sheets could be pushed back into the box.

*Length:* The 97 frames required a total of 128 responses. Before commencing the programme, learners had to complete a short sequence of 27 frames explaining how the programme and its machine operated; this was essential as some of the questions in the main programme depended for their answers on what had been taught in the 27-frame sequence.

*Criterion Behaviour:* After completing this programme, students should be able to:

(a) state three important ways of learning;
(b) state two other ways of learning;
(c) state what receptors people should use when learning;
(d) state how a good teacher gets the attention of his pupils;
(e) state whether repetition helps learning;
(f) differentiate between clear and obscure language as used in teaching;
(g) indicate the importance of knowledge of results for the learner;
(h) identify an example of varied repetition used correctly;
(i) identify wrong forms of motivation of the learner and state why they are wrong.

### The First Validation

*The sample:* Twenty-eight participants on a course for extension methods training; the length of service of the participants varied from six months to 25 years.

*Administration:* The purpose of the programme and the basic working of the machine (box) were first explained. A pre-test was given. Cheating was advised against. The class was taken through the first three frames as a group. The participants were told to call for help if required. The post-test followed, being identical to the pre-test.

*Time:* The time taken to complete the pre-test, the explanatory programme, the main programme and the post-test varied from 1 hour 20 minutes to 2 hours 30 minutes. There appeared to be some correlation between time taken and age of the learner.

*Attainment:*

**Table 38. "How People Learn" First Validation: attainment**

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 45·6% | 91·2% |
| Range .. .. | 0–67% | 84–100% |

*Error rates:* No attempt was made to calculate actual error rates, but note was taken of all frames which gave rise to a query from a participant. It appeared that most of the difficulties raised could be removed by altering the wording.

*Conclusions:* It was noticeable that in the overall course, informed discussion took place much sooner than had been experienced when the topic of how people learn had been taught by conventional means. The post-test scores showed a good increment when compared with the pre-test results.

### The Second Validation

*The sample:* Three separate groups, totalling 64 persons, made up the sample:

(a) 31 extension assistants;
(b) 13 extension assistants;
(c) 20 co-operative assistants.

All these persons were being trained for further work in the field.

*Administration:* The programme was administered in the same way as for the first validation, except that participants were asked to list frames they found to be difficult.

*Time:* The time taken to complete the programme varied from 1 hour 10 minutes to 1 hour 40 minutes.

*Attainment:* The pre-/post-test was modified after the first validation to eliminate the prompts which made it somewhat too easy when used as pre-test. As expected, this had the effect of lowering pre-test scores; post-test scores remained satisfactorily high.

**Table 39. "How People Learn" Second Validation: attainment**

| | | Pre-test | Post-test |
|---|---|---|---|
| Mean | (a) .. | 26·4% | 77·5% |
| | (b) .. | 31·2% | 76·7% |
| | (c) .. | 28·7% | 84·8% |
| Range | (a) .. | 0–53% | 27–93% |
| | (b) .. | 0–60% | 53–100% |
| | (c) .. | 0–60% | 80–100% |

It should be noted that all those in (a) and (b) groups had received previous instruction in extension methods sometime within the previous five years. One from (c) group had completed a teacher training course.

It should also be noted that an item analysis of the pre-test and post-test answers showed that one question in the test was too difficult without a prompt, that another question needed to be modified in format, and that the example quoted to test criterion behaviour (i) stimulated too many irrelevant responses.

*Error rates:* The mean rate for the whole sample was 2.6%, which may be said to be unusually low, but three frames had rates of more than 10%, thus indicating a need for modification. Five others yielded rates of more than 5% but less than 10%; these may not be altered, as four of them were introductory in nature and asked fairly open-ended questions. Two frames appeared to be far too easy. Other modifications will be made to a few frames which seemed to need improvement.

*Conclusions:* A further validation, after the modifications have been made, should prove the programme suitable for general use.

### The Third Validation

*The sample:* Twenty-five assistants took part in the third validation.

*Administration:* The same steps were followed as in the first and second validations.

*Time:* The time taken to complete the programme varied from 1 hour 5 minutes to 1 hour 50 minutes.

*Attainment:*

Table 40. "How People Learn" Third Validation: attainment

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 21·8% | 75·7% |
| Range .. .. | 0–50% | 44–100% |

*Error rates:* No sampling of error rates was made.

*Conclusions:* No further modifications of this programme are now intended. It is available for use in the extension training course.

## No. 11

### The Programme

*Title:* OCCASIONAL LEAVE CONDITIONS IN THE RHODESIAN PUBLIC SERVICE (for Grade 'O' employees, clerical, executive and administrative officers).

*Author:* J. B. Maguire.

*Level:* Grade 'O' employees (below Cambridge School Certificate) and Band 'A' officers (junior clerical officers). These are the persons for whom the programme was designed. They are taken into the Public Services Training Centre in batches for training. All are adults with primary schooling plus some secondary schooling.

*Type:* Linear.

*Form:* Booklet 13 in. by 4 in. Answers on left of the succeeding frame (page). No anti-cheat provision.

*Length:* Twenty-one frames contained 41 responses. The responses were to be written in the books, which remain the property of the pupils.

*Criterion Behaviour:* After completing the programme learners should be able to:

(a) state that all leave is a privilege and not a right;
(b) state the purpose of occasional leave;
(c) state that occasional leave is based on the calendar year;
(d) calculate how much occasional leave an officer or employee may be granted during his first calendar year;
(e) state who grants occasional leave;
(f) recognize that occasional leave not taken in any one calendar year is forfeited;
(g) calculate how much occasional leave an officer or employee may be granted in any calendar year other than his first calendar year;

(h) exclude Sundays and Public Holidays when counting up occasional leave due;
(i) state why Sundays and Public Holidays are thus excluded;
(j) state the types of leave that can be added on to occasional leave;
(k) apply the rules governing occasional leave in a variety of cases.

### The First Validation

*The sample:* It was not possible, for internal reasons at the Training Centre, to include in the sample the exact group for whom the programme was intended. Instead, the programme went through a first validation with two groups of persons who might be expected to have had a good knowledge of the subject. Thus some of the objects of validations were defeated. Group A had 13, B had 12 pupils.

*Administration:* The pre-test was given, then the programme. Instructions for use of the programme were contained in its first few pages. The post-test was given on completion of the programme and was identical to the pre-test. Discussion of the programme yielded some helpful comments for the experimenter.

*Time:* No record of time required to complete the programme was kept in the first validation.

*Attainment:* The pre-test used in Group A included only ten questions; this proved to be an inadequate tool for sampling learners' knowledge. Accordingly, it was re-written to include 25 questions. This version was used for Group B.

**Table 41. "Occasional Leave in the Public Service" First Validation: attainment**

| | Pre-test | Post-test |
|---|---|---|
| Group A mean .. .. (Test 1) | 56% | 83% |
| Group B mean .. .. (Test 2) | 71% | 86% |

The high pre-test scores are attributable to the fact that the groups were not those for whom the programme had been written (see above under *The sample*).

*Error rates:* The overall error rate was low, being 3.2%, but again this must be attributed partly to the fact that the groups had previous knowledge of the subject.

*Conclusions:* The completely inadequate wording of one frame was pointed out by the groups. This frame has been corrected. A second validation is to be carried out, using the revised version of the pre-/post-test and the second edition of the programme.

## No. 12

### The Programme

*Title:* INTRODUCTION TO GENETICS (PARTS I AND II).

*Author:* Edward J. Kormondy (Oberlin College, Ohio).

*Publisher:* McGraw-Hill Book Company.

*Level:* Originally written for American college students, the text was used in Rhodesia for students preparing for the A-level examination, which is the normal entrance requirement for entry to British Universities (and the University College of Rhodesia), being taken after 13 or 14 years of formal education.

*Type:* Linear.

*Form:* The book is in six parts, containing 24 lessons, but only the first two parts (Lessons 1-10) were used in this experiment. The vertical format offers about six generally short frames to a page, with the answers appearing on the left-hand side next to the relevant questions. For this experiment answers were written on a separate sheet.

*Length:* The 605 frames of Parts I and II require a total of over 1,000 responses, mostly consisting of a single word. Sometimes a short statement is elicited.

*Criterion behaviour:* The author states the aim of the programme to be to develop vocabulary, principles and concepts concerning reproduction and basic genetics. No specific statement of criterion behaviour is offered. Part I is headed *Cell reproduction* and includes mitosis, meiosis and gametogenesis. Part II is headed *Basic Mendelian genetics* and teaches terminology, probability in genetics, the monohybrid and the test cross, and the dihybrid cross.

## The Validation

*The sample:* Nine students being prepared for Cambridge Higher Certificate Biology were included in the experiment. Only two of the students had studied genetics properly; two others had touched upon it briefly before.

*Administration:* No pre-test was given, as the majority of the students had no previous knowledge whatsoever of the subject. The students were told how to use the programmes; complete instructions are also contained in the book. Two post-tests were given, one at the end of each of the two Parts used in the experiment. The tests were identical to those devised for testing first-year medical students using the same programme (a report on the experiment has been submitted to an American journal), and were of the objective type.

*Time:* Parts I and II were thought by the author to amount to about 10 hours' reading. Accordingly, 4 class periods of 2¾ hours each were allocated for the experiment. Subsequently it was found that this time allowance was somewhat too generous, most of the students requiring only about eight hours, this being considerably less than the normal teaching time given.

*Attainment:* The students stated they had no difficulties of comprehension, but later oral questioning showed up one or two points not fully understood by all. Table 42 shows test results.

Table 42. "Genetics" Validation: attainment

| | Test 1 | Test 2 |
|---|---|---|
| Mean .. .. | 83·8% | 78·4% |

*Error rate:* No check was made on students' error rates.

*Attitude:* The students' attitudes towards the new method of learning ranged from neutral to strongly positive. They would have liked to have used other programmes.

*Conclusions:* Although the attainment figures have no comparative values except against the means gained by the first-year medical students mentioned earlier, which were 84.1% and 79.2% respectively, the instructor was satisfied that the course had been completed. Subsequently, a question on genetics in a terminal examination paper was well answered. The final examination being an external one, there has been no way of checking these students' performance on the genetics question in it.

## No. 13

### The Programme

*Title:* DECIMAL FRACTIONS.

*Author:* J. R. Richards.

*Level:* The programme was written for final-year primary school pupils with about seven years' formal schooling.

*Type:* Linear.

*Form:* A booklet with quarto-sized pages having more than one frame, answers appearing on the left of the succeeding frame. No anti-cheat provision. There are 11 sections, each under a concise heading.

*Length:* The 68 page booklet contains 220 frames requiring 709 responses.

*Criterion behaviour:* Evidence of attainment of the objectives will be obtained through a written test which samples each objective. In the test, the pupil should be able to:

(a) write fractions in both vulgar and decimal form, up to three places of decimals;
(b) convert vulgar fractions having denominators which are factors of 10, 100 or 1,000 into decimal fractions;
(c) convert decimals of up to three decimal places into vulgar fractions, in their lowest terms;
(d) state the place values in a decimal, up to three decimal places;
(e) set down correctly examples of addition, subtraction, multiplication and division of decimals, the multiplication and division being in either long or short format;
(f) add decimals, having up to six digits;
(g) subtract decimals, having up to five digits;
(h) by either short or long multiplication methods, multiply decimals having up to six digits by an integer;
(i) divide decimals of up to six digits by an integer, by use of either short or long methods;
(j) multiply a decimal by 10, 100 or 1,000;
(k) divide a decimal by 10, 100 or 1,000;
(l) multiply a decimal of up to five figures by a decimal comprising of a single digit;
(m) multiply a decimal of up to five digits by a decimal of up to three digits with the use of either short or long multiplication methods;
(n) divide a decimal of up to four digits by a decimal comprising of a single digit;
(o) divide decimals, dividends being comprised of up to five digits, divisors of up to two digits, by either short or long division methods, to either two or three decimal places.

### The First Validation

*The sample:* Twenty-five pupils (20 girls, 5 boys) in the final year at a European primary school were included in the sample. They had been introduced to decimals the previous year but had done no revision subsequently. The class's mean chronological age was 12¼ years. Scores on the South African Group Test, Intermediate (Total) in July 1965 had ranged from 104 to 145+, giving a mean of 122 with an S.D. of 12.2.

*Administration:* The class was told the reason for the experiment and the pre-test was given. Work on the programme began the following day, and answers were written in the booklets. Post-tests were given immediately the programme had been completed.

*Time:* Lessons were of 40 minutes' duration. A short time for review of completed frames was allowed before the timed lessons. Instructions in the programme told the pupil to inform the teacher when he had finished a section. Table 43 shows times for the programme, by section and overall.

**Table 43. "Decimal Fractions" First Validation: times**

| Frames | | First Pupil | First Six | Whole Class | Mean |
|---|---|---|---|---|---|
| 1– 27 | .. | 17 | 28 | 42 | 32 |
| 28– 55 | .. | 15 | 27 | 39 | 30 |
| 56– 60 | .. | 10 | 13 | 22 | 14 |
| 61– 70 | .. | 26 | 37 | 68 | 47 |
| 71– 89 | .. | 11 | 14 | 29 | 18 |
| 90–108 | .. | 8 | 12 | 19 | 14 |
| 109–153 | .. | 50 | 66 | 114 | 80 |
| 154–183 | .. | 16 | 29 | 45 | 33 |
| 184–194 | .. | 11 | 26 | 45 | 30 |
| 195–203 | .. | 18 | 28 | 52 | 33 |
| 204–220 | .. | 15 | 20 | 47 | 28 |
| 1–220 | .. | 228 | 318 | 460 | 356 |

From this table it can be seen that the slowest took more than twice the time of the quickest to complete both the sections and the whole programme.

*Attainment:* Attainment scores are shown in Table 44.

**Table 44. "Decimal Fractions" First Validation: attainment**

| | Pre-test | Post-test |
|---|---|---|
| Mean .. .. | 37·8% | 86·1% |
| Range .. .. | 80% | 52% |
| S.D. .. .. | 17·3 | 13·6 |

It is interesting to note that the S.D. of the scores in the post-test was considerably smaller than that of the pre-test scores. On item analysis, it was found that the test needs revision, one item being insufficiently discriminative and another being ambiguously worded.

One might say that results on the post-test could not be considered to be truly satisfactory until each pupil attained 100%, as each test item tests a particular objective. Such perfect performance is unlikely, however, on account of computational errors. The sampling could be widened by including in the post-test more than one example of each process.

*Error rates:* Error analysis within the programme revealed that the sections of the programme dealing with conversion of vulgar fractions to decimals, multiplication and divisions by integers (two digits), multiplication by a single digit, and division by 1,000 require considerable revision. Table 45 shows error rates, by section and overall.

**Table 45. "Decimal Fractions" First Validation: error rates**

| Frames | % | Frames | % | Frames | % |
|---|---|---|---|---|---|
| 1–12 .. .. | 3·8 | 84– 86 .. .. | 7·1 | 128–153 .. .. | 15·0 |
| 13–27 .. .. | 18·7 | 87– 89 .. .. | 14·1 | 154–183 .. .. | 9·9 |
| 28–38 .. .. | 8·7 | 90–102 .. .. | 8·9 | 184–194 .. .. | 9·2 |
| 39–55 .. .. | 9·6 | 103–104 .. .. | 3·0 | 195–203 .. .. | 27·3 |
| 56–60 .. .. | 26·0 | 105–108 .. .. | 7·5 | 204–218 .. .. | 22·4 |
| 61–70 .. .. | 19·7 | 109–115 .. .. | 21·9 | 219–220 .. .. | 36·0 |
| 71–83 .. .. | 12·3 | 116–127 .. .. | 16·2 | 1–220 .. .. | 13·5 |

Over the whole programme, the lowest error rate was 3.8%, the highest 47.5%, and the median 9.7%. It is worth noting that apparently the high error rate on some sections did not lead to much cheating (otherwise the rate would not have been so high!). Individual error rates are shown in Table 46.

Table 46. "Decimal Fractions" First Validation: individual error rates

| Rate | N |
|---|---|
| Below 5% | 2 |
| 5–10% | 11 |
| 10–15% | 4 |
| 15–20% | 2 |
| 20–25% | 3 |
| 25–30% | 2 |
| Over 30% | 1 |

As there was no anti-cheat device, these figures cannot be entirely reliable, but they do emphasize the difficulty of constructing a programme which, while extending the most able, produces satisfactory error rates for the weaker members of a group. Skipping sequences are needed to cater for wide ability and attainment ranges.

*Correlations:* The Spearman rank order correlation coefficients were calculated between various measures and are shown in Table 47:

Table 47. "Decimal Fractions" First Validation; correlations

|  | Post-test | Time* | Errors† | Pre-test | I.Q.‡ |
|---|---|---|---|---|---|
| Post-test | — | —·31 | +·64 | +·54 | +·55 |
| Time |  | — | —·02 | +·32 | +·43 |
| Errors |  |  | — | +·34 | +·57 |
| Pre-test |  |  |  |  | +·51 |

* Time taken to complete programme: shortest ranked first.
† Errors made in programme: least ranked first.
‡ South African Group Test—Intermediate (Total)—July, 1965

*Note:* rho must be greater than .336 to be significant at the 5% level with N at 25.

It is significant that the highest positive correlation appears between errors and post-test, this supporting Skinner's dicta concerning error-rates. The substantial correlation between pre-test and post-test shows that the pupils having adequate entering behaviour tended to retain their advantage throughout the programme and post-test. Perhaps expectedly, there are low correlations obtained between pre-test rankings and error rate, and between pre-test rankings and time. The numbers of errors is independent, it seems, of the time taken. Speed in completing the programme does not correlate highly with success in the post-test. The negative figure obtained can probably be attributed to some cheating by weaker pupils as compared to a steadier approach by the more able, but the figure is not significant at the 5% level.

Of particular note are the substantial correlations between I.Q. and all four other measures. It seems that the higher I.Q. pupils in general work more carefully through the programme, without too much emphasis on the desire to finish quickly, or perhaps it may be said, conversely, that the less able are more likely to become discouraged and either work carelessly or cheat.

*Conclusions:* The first object of revision would be to achieve a lower and more constant error rate. Analysis of the errors should enable this to be done. Included in the revision would be more criterion frames and consequent skipping sequences, thus shortening the programme for the more able.

As a whole the programme would probably be shortened. The slowest pupil took 460 minutes to complete the programme, considerably shorter than it would take to teach the same skills by conventional methods.

It might be feasible to use the programme simply to teach the processes, providing extra examples from a suitable existing text. The programme would again be shortened by this.

## No. 14

### The Programme

*Title:* THE SECOND REPUBLIC IN FRANCE, 1848-52.

*Author:* C. J. Lawless.

*Level:* The programme is designed for pupils studying for G.C.E. Ordinary Level (11 years of formal schooling). It is specifically aimed at pupils in the first year of a two- or three-year course.

*Type:* Linear.

*Form:* Roneoed on foolscap paper, with frames going straight down the page and answers immediately opposite. No anti-cheat provision. Provision is included for the making of notes at intervals, and outlines for this form are ancillary to the programme.

*Length:* 26 pages, 176 frames, 510 responses.

*Response mode:* Constructed (written in) responses were used mainly, but some multiple choice answers were also included.

*Entry behaviour:* Ability to explain the main developments of Louis Philippe's reign up to the moment of his flight in February 1848, as shown in writing a history essay of Ordinary Level standard and in answering an objective test.

*Criterion behaviour:* Ability to explain the developments in France of the years 1848-52, the reasons for the failure of the Second Republic and the rise to power of Louis Napoleon, as shown in writing a history essay of Ordinary Level standard and in answering an objective test.

### The First Validation

*The sample:* Ninety-six boys in forms IIIA, IIIM and IIIB at a European high school, aged about fifteen, and in the first year of the G.C.E. Ordinary Level history course.

*Administration:* A pre-test was given, then the boys worked through the programme, recording the time taken and the frames covered in each period of work, on a time sheet. In IIIA and IIIM most pupils completed the programme entirely in class, only the slower ones completing it for homework. In IIIB, because of the proximity of the half-year examinations, all pupils had to do some work at home too.

*Attainment:* The table below indicates both attainment and times for the objective test devised:

**Table 48. "Second Republic" First Validation: attainment and times**

| Class | N | Pre-test | Post-test | Time |
|---|---|---|---|---|
| IIIA .. .. | 33 | 8·1% | 89·3% | 3 : 25 |
| IIIM .. .. | 31 | 7·6% | 84·6% | 4 : 05 |
| IIIB .. .. | 32 | 5·0% | 78·4% | 4 : 50 |
| Means .. .. | | 7·0% | 84·0% | 4 : 06 |

These scores indicate that the programme *did* teach.

Since the criterion behaviour specified also that an essay should be used, a comparison was made between the mark achieved in an essay on the topic and the average essay mark of each boy in previous essays during the term, in classes IIIA and IIIM. A 5% mark-up in IIIA and a 6.5% mark-up in IIIM was noted, in favour of the essay on the Second Republic. Clearly this mark-up might be attributable to the Hawthorne effect, on the pupils and the marker, but that criticism applies to most experimental work in schools.

*Error rate:* Seventeen responses (out of 510) showed error rates of over 10% and appear to need attention. Table 49 gives other data:

Table 49. "Second Republic" First Validation: error rates

| Class | Mean errors | % errors |
|---|---|---|
| IIIA . . . . | 9·5 | 1·9 |
| IIIM . . . . | 10·6 | 2·1 |
| IIIB . . . . | 19·7 | 3·9 |
| Means . . . . | 13·2 | 2·7 |

In general, the error rate was rather low, indicating that the programme could be shortened without causing too high a rate, or possibly that cheating reached a high level. The latter is not thought likely.

*Response point:* In IIIA half the class responded on the pogramme itself, half on a separate sheet of paper. No significant differences were noted in attainment or error rate, but the second group did require 3 hours 37 minutes whilst the first group needed 3 hours 10 minutes, on average, to complete the programme. This result was expected, as it is more cumbersome to work on separate sheets of paper.

*Pupils' attitude:* A simple attitude test was administered after the programme and post-test were completed. Results showed that in all three classes the majority of pupils felt that a programme was easier to use than ordinary texts, led to better understanding and was worth using again for some other topic. Opinions were more varied about whether the programme was interesting or boring, too repetitive or not, to be used all, most, or some of the time. Of particular interest was the trend down the scale of ability: IIIA showed rather more negative attitudes to this particular programme than did IIIB, where 15 pupils were in favour of using programmes all the time. IIIB's result may be attributed to their flush of success after a long record of comparative failure. Most pupils in all classes felt that their notes were at least as good as those they normally made but the suggestion that notes should be made more frequently by pupils working through the programme is to be taken up.

*Conclusions:* The programme was found to be too long. Firstly, too much material was covered: the programme should be divided into two halves, each being validated separately. The post-test was also too long to administer in one 40-minute period. Secondly, there was too much repetition in the programme. This was shown on a flow-chart constructed to indicate in which frames each concept was mentioned or tested.

Changes in content (as opposed to technique) could also be made. For instance, changes in order of material should help the pupils to discriminate better between the Provisional Government and the Assembly, over which they had difficulty in both programme and post-test. Deeper insight for the pupils could be gained by adding material at some points, e.g. a short section dealing with the settlement of the constitution and the nature of the settlement could usefully be added after the 'June Days' and before Louis Napoleon's election as President. Similarly, some review sections need more discriminatory questions to help pupils identify correctly the various sections of Louis Napoleon's career, his different methods of winning support in these periods, and the support he gained at the different stages.

This experiment was an exercise in validation, not a comparison of programmed instruction and conventional teaching. Nevertheless, from the scores on the post-test and the comparison of essay marks, it would seem reasonable to suggest that programmed instruction can provide teaching which is at least equivalent in results to the orthodox. After marking the examination scripts of classes IIIA and IIIM, the master-in-charge of history (not the experimenter) commented on how well those who answered a question on the Second Republic knew their facts

# CHAPTER FOUR

# ACCOUNTS OF EXPERIMENTS

Apart from the *Technical Reports on Programmes and Validations*, which appear in Chapter Three, there exist also several accounts of experiments in the use of programmed learning in Central Africa, of a different kind. These experiments were not sufficiently rigorous to yield the kind of data which would be properly reported in Chapter Three, but they contain much of interest. In particular, the reactions of both teachers and pupils to programmed learning have been commented upon.

There are three main experiments reported here: the first involved the use of Encyclopaedia Britannica TEMAC programmes in European secondary schools of the Federal Ministry of Education, and in one Training College for non-Africans; this report is published by permission of the Rhodesian Ministry of Education. The second describes work in African primary schools. The third is an account of programming by a mathematics teacher in a multi-racial public school.

The remainder of the chapter is devoted to reviewing research current in 1966.

## The Use of the TEMAC Programmed Course in Elementary Algebra

### A: At secondary school level (Prince Edward School)

Book I was issued to the IA maths set at the end of Term I, immediately after the grading of boys from Forms IA, IM and IB into maths sets following the April examinations. The last ten days of Term I were devoted exclusively to TEMAC, whilst during Terms II and III, two single periods (one on Wednesday morning and one on Wednesday afternoon) were used each week, together with the Wednesday night preparation. The course was broken off one week before the examinations at the end of these two terms.

Notebook and pencil were used for the recording of answers. No check was made on neatness or accuracy of work during class periods, but the children were instructed to ask for help immediately they failed to understand a frame. Wherever possible they were referred back to previous instruction to help them. Only on one or two occasions was the blackboard used to supplement instruction where the same question had been asked several times.

Supplementary books were issued as required, and pupils were supplied with graph paper when the section on linear graphs was reached. The book of suggested tests was used periodically to test progress.

The programme enabled each child to proceed at his own pace. The slower ones were encouraged to do extra whenever possible in order not to fall too far behind, but the two very slow workers in the set did in fact lag a long way. They had the time to master what they had done, however, and showed in the tests that they were as good as the others on that material. Constant repetition and revision of work is good for any boy slow to understand at the first explanation.

Larger classes than the traditional thirty could be handled by the programmed method. Occasionally the teacher was kept very busy answering queries, but in some periods there were not more than five or six questions in 40 minutes.

For IA the most damning aspect of this technique was the boredom they said they felt. After the first novelty wore off, the proportion of the class which was bored increased. Monthly questionnaires were used to test reaction, and by the middle of Term III *all* the pupils said they were bored. An attempt was made to omit sections of repetitive work, but the danger of breaking continuity of explanation made this difficult.

The pupils also experienced difficulty in interpreting the jargon; this added to the slowness and boredom. The text's explanations were generally lucid from the adult point of view, but were given in only one form, whereas the teacher can alter his explanation to suit the class.

The course did not fit in well with the Form I syllabus. For instance, directed numbers, formulae and problems were introduced too early. Equation work was kept to one or two steps throughout Books 1 and 2, long multiplication and division were introduced only in Book 2, there was a fair amount of graphical work in all three books, and in general the type of example was easier than normal in Form I. Hence some class teaching had to be done to prepare the class for the common Form I examinations in August and December. Ideally the course should be taken by a form divorced from the normal school syllabus and examinations.

A bad point against the author was the misprints left in the text. In a self-teaching course it is essential that all errors be revised out of the text, but at least ten were found by the boys in the first two and a half books.

Bearing in mind the fact that the experiment was not conducted under ideal conditions nor finally completed (the furthest any boy reached was halfway through the course), the first conclusion reached was that there was no evidence to suggest that time was saved. An A set could have covered as much ground as was covered by the course, possibly more, though the slower members of the set might have suffered confusion. As it was they were left far behind, and would have needed extra time to finish the course.

Secondly, in both the August and December examinations, all scored poorly in Algebra, the average being 10% lower than for Arithmetic or Geometry in December. But IM (who did not take the programme) also obtained their lowest average in Algebra, whilst IB did not, so no conclusion can be drawn from these figures.

Thirdly, the three top boys in IA Algebra in August all scored poorly in Algebra in December, losing their top places and making some quite elementary mistakes. Under class teaching they would have known perfectly the rules they broke.

The teacher said that from his point of view he was also bored by the programme and felt that he was largely wasting his time during the lessons in which TEMAC was used. He felt too that he could have done the teaching better than the programme could.

Both teachers and pupils felt that the course would have been more suitable for a third or fourth stream, where greater repetition is needed, although they recognised that the language difficulty would probably be greater there too.

The teacher claimed that he had tried to be unbiased in his attitude to the course, and had encouraged the boys to enjoy it, but said that while classes remain at their present size he felt the trained teacher could teach the work more effectively than the programme. The course would be more valuable, he said, if classes had to be increased in size, or if no trained teacher were available to take the work. In other words, he felt that the programme was a poor substitute for the good trained teacher.

### B: At teachers' college level (Teachers' College, Bulawayo)

The lecturer concerned with the validation of the TEMAC Algebra programme at student level still had somewhat mixed feelings about the programme after the experiment, although his overall impression was favourable.

Although the programme was shown to have some holding power, this was hardly great. The students who had worked conscientiously at the programme were those who were conscientious in their other courses too, but then it should be noted that the students were all volunteers who worked on the programme over and above their compulsory course work. As with all learning, other things being equal, the greater the effort made by the learner the greater his gain.

Several day-students reported considerable interest at home. One student reported that her sister was working remedially on the programme at Form 2 level; another wrote of a Standard 5 boy, to whom the programme was completely fresh, who attained considerable success using it. The boy's mother remarked that it was an ideal way for a parent to teach, as she had to help merely when he was stuck.

Some students found the programme too slow for them; skimming was advocated and helped a little, but branching is really needed to take care of individual differences.

In testing the students not only the TEMAC tests were used, but also some devised by the lecturer in charge of the experiment. No reports of retention were made.

From the teacher-training point of view, it was felt that to have the students work with a proper programme, rather than simply have them hear about programmes, was far more effective. The lecturer summed up by stating that although he felt that the TEMAC programme fell short of perfection, it could continue to be of considerable value to staff and students at the Teachers' College.

## The Use of the TEMAC Programmed Course in Geometry

### (Mount Pleasant School)

As the course was used for only three weeks in only one form, IA, the school concerned stated that it was premature to give a detailed appreciation of the effectiveness of the material. Further experiments, to include the less talented forms, and to introduce programmed texts at the beginning of mathematical studies, were suggested.

Most of the pupils in IA gave their opinion concerning the text after their limited use of it. They found the material to be effective for learning the element tary stages of mathematics without teacher guidance, but they needed tha- guidance when they came to the more advanced stages of the text, because they found that it was not able to settle an individual's specific difficulties. The class thought that the material would be less effective for the less talented; the student lacking in tenacity would tend to baulk at tackling more difficult problems. Some pupils suggested that the novelty of the programme might wear off, and that the personal impact of the teacher would again become necessary, stimulating interest in the subject. They agreed that the material minimized competition in a class in that each pupil could set his own pace depending upon ability, conscientiousness and tenacity. Some pupils thought that the text might force the pupil towards stereotyped thinking, with a possibility that the pupil would not bother to develop his own mental process, however illogical or inconsistent that might be. As a textbook, the programme was not much use when it came to referring to work previously studied: the arguments in the programme are developed lengthily, and the pinpointing of a particular difficulty in understanding is not easy.

The teacher using the material mainly agreed with the pupils' views, but thought they had over-stressed the point about stereotyped thinking, which she felt occurred a good deal in junior forms anyway. The teacher also felt that the material formed a useful aid to the teacher who has little qualification or feeling for mathematics; but that the material was more suited to an accumulation of facts or techniques rather than an understanding of mathematics. She felt that in an A stream there should be some pupils at least who would appreciate and benefit from a philosophy of mathematics in 'its beauty and elegance', and felt that philosophy could come only from a teacher with "mathematical personality, skill and appreciation."

## The Use of TEMAC Programmed Courses in Calculus and Trigonometry
### (Gifford Technical High School)

Although some experimenting was carried out using these courses, they were found to differ too much in subject-matter from the examination syllabuses. The presentation of the subject-matter was thought to be excellent, and the programmed approach appealed to members of staff.

Should there be changes in the examination syllabuses leading to the incorporation of modern mathematics, the school concerned would like to use TEMAC.

## Science Programmes in the African Primary School (Sr. M. B. Goller)

There is a world-wide movement to bring science into primary or elementary schools. Professor R. Karplus, head of the Science Curriculum Improvement Studies for Elementary Schools conducted by the Department of Physics of the University of California writes: "The present content of science consists of concepts and relationships that mankind had abstracted from the observation of natural phenomena over the centuries. During the elementary-school years boys and girls are engaged in precisely this kind of abstracting process with respect to their own natural environment. The function of education is to guide children's development by providing them with particular informative and suggestive experiences as a base for their abstractions. At the same time children must be provided with a conceptual framework that permits them to perceive the phenomena in a meaningful way and to integrate their inferences into generalizations of lasting value. This is precisely the scope of the elementary-school science programme. To use the elementary-school years only for the teaching of certain skills is to abdicate part of the responsibility for teaching during a unique period of intellectual growth."

This brings us right to the heart of the problem. As the child lives and grows up in his own world, it is more than justified to help the child to form correct concepts in the process of interpeting and assimilating the happenings of his surroundings.

For the African child another weighty reason supports the introduction of science into the primary school. He is compelled to live in surroundings which lack many experiences provided for children of his age at home in other countries. Nor does he have the guidance of experienced elders in science processes. So he enters secondary education or employment with a marked deficiency and all the drawbacks which arise from it. He is sometimes anxious, but more often afraid, to use and acquire modern machinery and equipment whose working to him is mysterious and suggests magic or witchcraft.

Questions at once arise about the choice of material and the extent to which children should explore and learn it. One line of thought is directed towards the acquisition of general qualitative ideas by means of play. Where secondary education for all is secured this is a splendid idea as it lays a good foundation for future work which can be built on the precepts and initial concepts gained during this time.

Yet for African children, the greater part of whom leave school before the seventh year, this is not sufficient. It would curtail their process of formal education and make them face a "physically controlled world" without understanding the main principles which rule it.

To teach these principles to the primary school child requires an exploration of the child's ability at his various stages in school, in order that we may provide him with all that he is able to do. The work of Professor Jean Piaget in co-operation with Professor Barbel Inhelder has established the foundation for such studies. Piaget's analysis of the child's mind at various stages of development related to mental age gives us a basis for the nature and kind of material to be taught.

Having decided on the latter, our attention must also be given to the method of teaching. As correct concepts are only formed on the base of correct percepts sufficient apparatus of a simple nature should be available to the learner. Due to individual differences the time to use it should not be cut short for slow learners nor prolonged unnecessarily for quick children.

This type of learning, as well as the guidance to be provided in the learning process is outside the scope of many African teachers in the primary school, especially in the lower primary. As they lacked this experience during their own time of learning and training they are not able to provide it for others. But if primary science teaching has to wait for newly trained teachers too many children will have to go through primary school without learning science.

Thus a new teaching method is required which explains the material to be learned, guides the use of apparatus, and tests the facts acquired in a way appropriate to the method of learning.

The method of programming seems to be most likely to provide the necessary explanation, guidance and testing.

As science material lends itself to programming, and programming can be extended to include guidance during practical work, programming seems to be ideal for the introduction of science in the primary school.

Keeping the preceding considerations in mind a science programme named *Magnetism* was prepared and the individual apparatus to be used with it. A second, *Electricity*, was started as well.

As no written records of the application of Piaget's work to African children exist, the programme *Magnetism* was taken to an African primary school to test its efficiency. This was done in October, 1964. The children were instructed about the purpose of the experiment and set to work with the programme. Though the programme was intended for Standard 5, a range of children from Standard 3 to Standard 6 was included in this first trial period. By examining children's questions and mistakes, Piaget's general principles on mental development were confirmed. This evidence, as well as the insight gained by working with slower children of higher Standards and the Standard 3 group, was applied to the re-shaping of the second programme, which was re-named *Heat and Light*, before being given to a Standard 3 group only. The matter proved suitable, but further difficulties were discovered due to lack of background experience, e.g. sense training.

To get further evidence on the reaction of African pupils to programming, the testing opportunities generously offered by one school (Empandeni Institution near Plumtree) were used further to test the programme *Magnetism* with pupils in Forms 1-4. The reaction of the pupils to the programme was very good. Those who had learned magnetism before by class-room methods welcomed the individual rate of working and the free use of apparatus, as well as the presentation of matter in programme form.

A further testing, using *Magnetism* and *Heat and Light*, was carried out in classes for African teacher-trainees, to find out their reaction to programming. Here too the reception was good, and by a lively discussion in both classes further insight was gained into African ways of thinking.

On the basis of information obtained a revision of the two programmes is being undertaken. These, as well as a third programme *Things Move: How do they Move?* will be tested in another primary school.

Much work has still to be done, but the interest of the chidren and the first results obtained, are very encouraging.

### Programming Mathematics: Report of an In-School Experiment (T. Plummer)

I remember well some four years ago talking with several R.A.F. Education Officers at F.E.A.F. Headquarters, Changi, Singapore. The subject of teaching machines came up. This was the first time I had heard of such contraptions, and being a teacher of some 30 years' standing I was very sceptical and rather rude. Unfortunately, these officers knew very little about the machines or the ideas behind them, and I was left in complacent ignorance for several months until I read an article in the *Times Educational Supplement* and another in the *Reader's Digest* about programmed learning.

I had been teaching mathematics for much of my teaching life, and had felt frustration for a long time, especially with the average and not so bright pupils. The bright boys were all right; the response was there and the end product most satisfying, but these were only a small proportion of the pupils passing through my hands. How could I make the subject more interesting? How could I give more individual attention to the slower members of the class without holding back the brighter ones? How could I restore confidence to the "can't-doers" and the "blind-spotters" of mathematics? How could I increase the pupils' input comparative to my output of knowledge? What was the point in carrying home piles of exercise books and ploughing through them in the absence of the pupils, and not being able to do somethig constructive about it? These were the questions which had forced themselves on me over the years, and I hadn't found a satisfactory answer by the time I read the articles on programmed learning.

I was always ready to give any method a try, and this method seemed reasonable. I started to programme a course in mathematics for a fourth year form, quite prepared at any moment to find that this was just another gimmick. I put into the programme as much experience as I had gleaned over the years in presenting the concepts I wished to teach, and away we went. I fed the knowledge to them in small doses, following each dose with appropriate questions and emphasizing points where, from experience, I knew snags would arise.

From the beginning the interest was there; the amount of work turned out was amazing; the atmosphere in the class was one of concentrated effort; the "can't-doers" were getting the answers right and were very happy about it. I was busy flitting up and down the class-room sorting out snags, keeping each pupil supplied with programme sheets, and still able to give individual attention where it was needed.

Then I had a piece of luck. After I had been doing this for about three months the R.A.F. Education people heard of my experiment, and sent one of their experts on programmed learning to Singapore. They had been experimenting for a long time in the training of apprentices and saw the possibility of using programmed learning in Service schools. They sent out S/L Thomas, now co-author of *Programmed Learning in Perspective;* he stayed some ten days, lecturing on the subject in the evenings and spending most of the days with me, since I was the only one doing this work in Singapore.

Fortunately for me, he found that I was on the right lines, and I learnt a lot from him, especially on the preparation of material before writing the programme.

I hadn't any teaching machines; the answers were on the back of the programme sheets, and the pupils checked by turning over these sheets to find the correct answer. This wasn't entirely satisfactory, since it did not eliminate cheating, but the pupils were very good about it on the whole. To get the *maximum* benefit, however, one must use a presentation device which is cheatproof, I have concluded.

The work continued for a year, and at the end of the year this form and a parallel form, which had had formal teaching on the same syllabus, sat the same examination—a London GCE Algebra 'O'-level paper they had never seen before.

The results in the two classes, expressed as percentages, were as follows:

Programmed Instruction: 86 76 70 68 67 65 64 64 53 49 47 47 45 42 35 14 13.
Conventional Instruction: 56 48 42 37 33 32 30 29 26 26 22 21 14 13 13 12 11.

Averages: Programmed Instruction 53.1: Conventional Instruction 26.7.

These results, and the fact that there was no diminution of effort during the year, convinced me that there was something in the method, and on coming to Salisbury I was permitted to continue with the experiment, but this time with a IVc class, whose record of work was very poor. It meant working from the beginning in Algebra. Again, the interest was there from the start—it always is with a new method, but the test comes in maintaining this interest. There was no trouble at all on this point, and the class went ahead steadily, working all the time and enjoying the work. They made such progress that I was asked to enter them for the 'O' level GCE at the end of the year—a year before they were due to take the examination. I wasn't too keen, knowing the amount of work to be covered: the basics had to be covered in addition to the examination syllabus. I decided to go ahead, and although the Algebra was covered adequately we could not finish the Arithmetic, Geometry and Trigonometry. There was, however, rather an interesting side issue. The programmes had stimulated the boys to work and this was reflected in their other subjects. So much so that three other masters decided to enter some of the boys for the examination.

Ten boys were entered for mathematics; the resulting grades were: 1 4 5 7 7 8 8 9 9 9. These were considered satisfactory in the circumstances. They were C-stream pupils taking the examination a year before their time. They did satisfactorily in other subjects, and some of the boys now have up to five subjects at 'O' level. During the whole year the boys were given tests at frequent intervals to assess their gains in knowledge, and the results were most encouraging.

The experiment is being continued this year, with a Third Form included, to try to cover the syllabus thoroughly and give ample time for revision.

Both the third and fourth form classes have taken to the programmes as enthusiastically as their predecessors.

The following results show that the aim of keeping the error rate down to less than 5% has been achieved. The odd pupil has a rate over 5%, but it has never been the same pupil all the time. Carelessness in reading instructions has been the main cause of errors, and as the pupils became more familiar with the method errors were less. Each error was checked with the individual making it, to ensure that he understood why the error had been made and that he fully understood the correct method.

**Table 50. Average error rates for different sections of 'O' level mathematics**

| | % |
|---|---|
| Foundations of algebra | 1·9 |
| Algebraic fractions | 3·0 |
| Logarithms | 2·4 |
| Trigonometry | 2·5 |
| Factorization in Algebra | 2·4 |
| Algebraic equations | 2·4 |
| Basic numerical geometry | 0·9 |

Experiments were also undertaken to produce a simple, inexpensive and cheat-proof machine or device. The emphasis in most machines seems to be to include both the programme (information and questions) and the answers in one machine. I worked on the principle that the important part of the machine was in the verification of the answers, with the elimination of cheating. The programme has therefore been taken out of the machine and is kept in a folder; the machine has been made purely and simply for checking answers. Several models have been tried out, and the final product has been in use for 15 months in my school. It is robust, simple to work, takes up no more space than a foolscap exercise book and has been perfected under actual classroom conditions. It is comparatively inexpensive.

The algebra programmes have already been published in the U.K. under the name of the Hillborough 1100 Series by Lamson Technical Products Limited. A set covering the 'O' level algebra syllabus costs £7 7s. 0d., the Hillborough device 35s. (it is not cheat-proof). In my opinion these prices are not realistic for schools.

What have I learned from these experiments and tests? As far as the tests are concerned, you may make of them what you will. That is true of the results of most experiments involving teaching methods. An eminent American psychologist recently listed the 217 variables in a normal educational setting which might have to be eliminated or neutralized before such experiments could prove anything. As a practical teacher I write and revise my programme until the average error rate is less than 5%; this was Professor Skinner's aim, and I am well satisfied to work within these limits.

The general conclusions I have drawn for myself from my experiences are:

(1) The programmes have proved successful with a considerable majority of the pupils who have used them.
(2) They appear to make an impact with pupils who have previously experienced failure in the subject.
(3) The pupils acquire a genuine interest in the subject and are keen to work.
(4) The pupils make more rapid progress using programmes than do parallel classes using conventional techniques.
(5) There is more individual contact between teacher and pupil.
(6) Progress of individual pupils is more evident and more easily checked.
(7) The material presented to the class has been more thoroughly prepared than is usually so.
(8) The teacher learns a great deal in the preparation of a programme, and is a better teacher after such experience.
(9) The teacher is relieved of much monotonous and repetitive marking. Instead there is interesting and rewarding analysis of results, leading to a feeling of achievement.
(10) Absences from class present no problems—the absentee continues

where he left off, on his return, and in my experience works harder to catch up.

(11) The whole classroom atmosphere is one of smooth efficiency and concentration.

(12) Programming in one subject has beneficial effects on other subjects due to attitudes of concentration and willingness to work being developed.

(13) Programmes are very useful for remedial work.

(14) Homework setting is redundant—the pupils carry on with the programme for the specified time. The work is done, and pupils even ask for holiday work.

These conclusions speak for themselves. I have been converted to programmed learning. I do not put the method forward as a panacea for all the ills that beset teaching. Certain subjects, especially those which consist largly of the teaching of techniques, are ideal for programming. Other subjects calling for the use of imagination and sensitivity cannot be so easily programmed, but in every subject there is some aspect that can be programmed usefully.

Teachers, as practical exponents of the art of imparting knowledge, can and should play a big role in the furtherance of this approach to teaching. The best and most rewarding line for the teacher to take is to try writing a programme and to experiment for himself. Make no mistake: it is hard and time-consuming work, but it is well worth while. To do it properly you should attend a course. If you haven't the time to write your own programme, there are many excellent (and some not-so-excellent) programmes on the market. Explore the possibilities of using programmed learning in your school.

### Summary of research current in 1966

This section summarizes various experiments which were proceeding under the auspices of the Programmed Learning Centre towards the end of 1966 and which have not already been discussed. Admittedly, the information here will rapidly become obsolete, but it gives an impression of the type and variety of research being undertaken.

**Simultaneous Equations**

This programme, written by K. Austwick, now Professor of Education at the University of Bath, has been published in Methuen's Clearway Series of programmed texts. It contains an approach to simultaneous equations which does not depend at all on graphical solutions. Some would criticize it on this ground, but the programme is characterized by a most lucid exposition of the various types of simultaneous equations and of their solution. Accordingly it was selected for adaptation to African conditions, by permission of the publishers.

The adaptation was not a difficult one; a few examples contained culture-loaded items which would not be familiar to African pupils, but substitution was not difficult. The format of the published English version was a little too complicated (involving two-colour printing) for reproduction for test purposes, therefore a new format was chosen, similar to that employed for most other programmes developed at the Centre. The adaptation was undertaken by D. G. Hawkridge.

To date only two uncontrolled experiments have been undertaken with the adapted version, and no detailed results are yet available. The time for the whole programme is at least three hours, and it has proved difficult to arrange test classes to work on the programme for the required number of periods. The programme appears to teach well, however, and a technical report on its use is expected.

**Vectors**

A post-graduate student, T. Draisma, wrote this programme concerning vectors, for use in the VIth Form (about 12 years of formal education). It contains a large number of diagrams, and this factor has held up its reproduction. The author, now lecturing in Zambia, has written several other programmes subsequently.

**Number Bases and Binary Arithmetic**

This programme, written by Learning Incorporated and published by Coronet Instructional Films Incorporated, has been adapted for research in Zambian and Rhodesian African schools by D. G. Hawkridge. To date a Zambian validation including 40 pupils has been completed but not yet reported.

**Semi-conductors**

The Post Office Training College has been the scene of a minor trial of an adaptation of Mullard Limited's *Semi-conductors*, a programme for trainees in electronics. R. Chittenden was responsible for the adaptation, with acknowledgement to Mullard Limited. The trial has indicated the need for further adaptation.

**Conversion of °F/°C and °C/°F**

The awkward conversion calculation necessitated by the use of two temperature scales, Fahrenheit and Centigrade, is the subject of a programme written by F. J. Brown and Jean Norris, post-graduate students training to be science teachers. The programme is linear, and takes about three hours to complete. The first attempt at validation could not be called successful, in that the time needed was seriously under-estimated, and most of the class could not finish the work in the time allowed. Some interesting points were noted from that attempt, however, and a second validation was subsequently undertaken at an African secondary school. The results are still to be reported, but an extension of that validation was made, including more classes using the same version of the programme.

**Introduction to Radar**

J. Thomas, the author of this programme, is in the Department of Civil Aviation. One of his tasks is to train Air Traffic Control Officers in Central Africa. For such personnel and others he has prepared an introduction to radar, in programmed form, which explains the main principles on which radar operates, and teaches the basic calculations necessary. He is validating the first edition, which was begun at a programming seminar, and has started to write a further programme dealing with more details of radar operation. The programme is modified linear.

**Storage of X-ray Films**

This programme, dealing with one of the topics taught to student-radiographers, was written by Anne Whitmore, Superintendent Radiographer at Mpilo Central Hospital, Bulawayo. It deals chiefly with the precautions to be taken in storing X-ray film.

**Introduction to Smallpox Vaccination**

Two doctors at Mpilo Hospital, W. Fraser Ross and N. Baldachin, wrote this programme, designed for student nurses and health assistants. A validation involving 31 trainees has been undertaken, the results of which will be published. Both the tests and the programme are to undergo some revision as a result of the validation.

**Red Blood Cells**

Winifred Hector of St. Bartholomew's Hospital, London, wrote this programme, which is to be published by Teaching Programmes Limited of Bristol.

This firm sent sufficient copies to Salisbury for a Central African validation to be carried out, using nurse trainees in Mpilo Central Hospital. The results of the first validation showed that some adaptation of the programme is needed to suit local conditions. A technical report on the experiment is forthcoming.

**Adverbial Clauses**

A part-time post-graduate student, Fay Chung, teaching in an African secondary school, experienced considerable difficulty in teaching this topic, and sought the help of her tutors. One suggested programming the topic, another gave her assistance in preparing the linear programme, and she herself set about validating it, after a number of setbacks. The detailed results of the first validation are yet to be reported, but the author states that on the basis of the data gained during the first validation she is now revising the programme in preparation for a second validation.

**The Apostrophe**

This programme was written by A. M. O'Brien to assist less able pupils to understand when and where to use the apostrophe in English. The first validation yielded quite high attainment post-test scores, but the author wishes to revise certain sections.

**Errors in English**

A Diploma in Education student, N. Padayachee, has written a programme for his Asian and Coloured pupils in secondary school who have difficulties in using English correctly. His programme is undergoing a first validation, and results are not yet available.

**Napoleon**

A second Diploma in Education student, C. J. Lawless, wrote this programme for his own secondary school pupils, to go with *The Second Republic* (see Chapter Three). The first validation is now completed. The author expects to revise the programme, re-validate it, and offer it for publication.

**Causes of Rainfall**

This programme, written by S. Salisbury with assistance from D. G. Hawkridge, is intended for Form III or Form IV. It deals with the causes of the three main types of rainfall, using a linear format.

Both African and European classes are to be included in the validation, to study cross-cultural effects.

**The Principles of a Contour Bank**

A member of the Department of Conservation and Extension, T. S. Davies, training officer at Kayisa Institute, Bulawayo, has written the first of a series of three programmes concerning the surveying of a standardized contour bank for the soil conservation of arable lands. This programme has not yet been validated. The author attended a programming seminar.

**A Building Society**

Zambianization of the employees of a building society in Lusaka led the society to seek new training methods. This programme serves as a basic introduction to the concept and purpose of a building society. The society feels that all employees should understand these matters. The programme has been tested on a small number of new employees, and minor revisions have been suggested.

**Duties of a Cashier**

The same building society as mentioned above has developed this programme to teach new cashiers their duties, the position of cashier being a key one in the promotional structure of the society. Again, a small number of new employees has tried the programme and some revisions are to be made.

### The Lamson Empirical Tutor

This programme was prepared to meet the specific demands of seminars for programme writers. On display at such seminars was a number of machines, amongst which appeared the Lamson Empirical Tutor, a complex electrical teaching machine. To demonstrate this machine's working to small groups or to individuals was known to be most time-consuming, therefore a short programme was written for the machine, which explains the way in which the machine works, and what its ancillary devices are able to do.

This programme, written by D. G. Hawkridge, was validated with various members of two seminars and a revised version is now being prepared.

### Rhodesia Railways Series

Twelve programmes dealing with various training tasks for Rhodesia Railways have been written by railways staff and are at various stages of development. Table 51 indicates details. Work is proceeding slowly, as the training officers concerned are coping with particular problems caused by political uncertainty.

### Barometric Pressure Control

This is a programme written to help technical ground staff trainees to understand the operation of the barometric pressure control unit in aircraft. The author, G. P. Proudfoot, is a member of staff at the Ground Training School, R.R.A.F., Salisbury, and attended a programming seminar.

The programme is a linear one, and has completed its first validation, which is still to be reported. Revision is now proceeding to prepare the programme for a second validation with another batch of trainees.

### A Tutorial Course in Statistics

Post-graduate Certificate in Education students facing a compulsory statistics course have in the past made use of published programmes. These programmes did not fit their syllabus exactly, however; consequently a more suitable programme has been written by D. G. Hawkridge. It cannot easily be validated in the normal way, but with revision based on the remarks of students may provide a useful teaching tool.

### Bio-statistics

Medical students at the University College have used the TMI-Grolier *Introductory Statistics* for two years running now to follow their bio-statistics course. Although excellent in many respects, the TMI-Grolier book is too general. Accordingly, a member of the Medical School staff is now writing a course to suit the students' specific needs. It will be tested in 1967.

### Tests of Published Programmes

The work during 1964-66 on the testing of published programmes has been mentioned in Chapter One. In particular, it should be noted here that the results of testing TMI-Grolier programme *Introductory Statistics* have been good, and this programme may be used again, in both the Faculty of Education and the Faculty of Medicine, pending the production of locally-written programmes.

Similarly, McGraw-Hill's *An Introduction to Genetics* has produced results which amply justified its inclusion in courses in 1966.

Testing of Collier-Macmillan's *General Science Programmed Learning Laboratory* was restricted to Book 3 in 1965.

Small-sample testing of a wide range of other published programmes proceeds continuously.

The results of all major experiments using published programmes are reported in the *Information Bulletin* and articles describing this work are published in various learned journals.

Below is a short list of such articles:

**Publications concerning Programmed Learning Research in Central Africa**

1. Hawkridge, D. G. Educational technology in the African context. (Series of three articles).
   Journal of Education of New Africa, July, August and October, 1964. Out of print.
2. Hawkridge, D. G. A cybernetical approach to teaching.
   R.T.A. Journal, Nov. 1964.
3. Hawkridge, D. G. Programmed learning research in Central Africa.
   OVAC Bulletin, Oct. 1965.
4. Hawkridge, D. G. First results of programmed learning research in Central Africa.
   Journal of the Association for Programmed Learning, Feb. 1966.
5. Hawkridge, D. G. Programmierter Unterricht in Zentralafrika.
   Programmiertes lernen und programmierter unterricht, 2, 1966.
6. Hawkridge, D. G. Programmed learning and teacher education.
   Teacher Education, 6, 3, Feb. 1966.

Table 51 shows the state of development of all programmes which have passed their first editorial stage under the aegis of the Programmed Learning Centre of the University College.

Table 51. Development of programmes

| TITLE | EDITIONS | | | | | Technical Rept. Nos. | Total pupils tested so far | Pages ? | Age group: years | AUTHOR(S) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Write 1–2 | 3 | Validate and Revise 4 | 5 | 6 | | | | | | |
| How to Learn Step by Step | C | 88<br>C | PA | — | — | 3 | 88<br>A | 6 | 14 | D. G. Hawkridge | |
| Simple Contours | C | 63<br>C | 202<br>C | 183<br>C | 92<br>P | 1, 5, 12 | 540<br>A(E) | 32 | 14 | D. G. Hawkridge and W. D. Michie | |
| Map Scales | C | 83<br>C | 160<br>C | R | — | 2, 13 | 243 | ? | 14 | D. G. Hawkridge and W. D. Michie | |
| Simultaneous Equations | AD | 60<br>P | — | — | — | — | 60<br>E | 100 | 14 | K. Austwick (Ad. D. G. Hawkridge) | |
| Introduction to Indices | C | 92<br>C | R | — | — | 8 | 92<br>A | 25 | 13 | R. Hicks and D. G. Hawkridge | |
| Programmed Learning: A Layman's Introd. | C | 32<br>C | 57<br>C | 60<br>C | R | 6 | 149<br>E/A | 20 | 21* | D. G. Hawkridge | |
| The Lamson Empirical Tutor | C | 25<br>C | R | — | — | — | 25<br>E | 30 | 21* | D. G. Hawkridge | |
| Vectors | C | — | — | — | — | — | E/A | 30 | 18 | T. Draisma | |
| Adverbial Clauses | C | 70<br>C | R | — | — | — | 70<br>A | 15 | 14 | F. Chung | |
| Barometric Pressure Control | C | 12<br>C | R | — | — | — | 12<br>E | 20 | 21* | G. P. Proudfoot | |
| Occasional Leave in the Public Service | C | 25<br>C | R | — | — | 17 | 25<br>E | 21 | 21* | J. P. Maguire | S |
| Semi-conductors | AD | 5<br>C | R | — | — | — | 5<br>E | 20 | 18* | Educational Systems (Ad. R. Chittenden) | S |
| Introduction to Radar | C | 20<br>C | R | — | — | — | 20<br>E | 15 | 21* | J. D. Thomas | S |

Table 51. Development of programmes

| TITLE | EDITIONS<br>Write 1–2 | 3 | Validate and Revise<br>4 | 5 | 6 | Technical Rept. Nos. | Total pupils tested so far | Pages ? | Age group: years | AUTHOR(S) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat | C | 25<br>C | 25<br>C | R | — | 4, 7 | 50<br>E | 25 | 15 | D. R. White | |
| Red Blood Cells | AD | 20<br>C | — | — | — | — | 20<br>A | 90 | 20* | W. Hector<br>(Ad. D. G. Hawkridge) | |
| 1802 Factory Reform Act | C | 48<br>C | R | — | — | 10 | 48<br>A | 25 | 16 | C. H. Bickerton | |
| Causes of Rainfall | C | 65<br>P | — | — | — | — | 65<br>A | 20 | 16 | S. Salisbury and<br>D. G. Hawkridge | |
| Noun Clauses | C | 34<br>C | R | — | — | 9 | 34<br>A | 20 | 14 | J. Sutton-Smith and<br>P. Pearce | S |
| Conversion of °F/°C and °C/°F | C | 35<br>C | R | — | — | — | 35<br>E/A | 20 | 15 | F. J. Brown and<br>J. Norris | S |
| Town and Country | C | 28<br>C | 27<br>C | 24<br>C | PA | 14 | 79<br>A | 50 | 21* | J. D. Jordan | S |
| How People Learn | C | 28<br>C | 64<br>C | 25<br>C | — | 16 | 117 | 14 | 21* | J. D. Jordan | S |
| Storage of X-ray Film | C | — | — | — | — | — | E/A | 25 | 20* | A. Whitmore | S |
| Roots and Surds | C | 29<br>C | R | — | — | 11 | 29<br>A | 37 | 16 | W. Read | |
| Things Move | C | 40<br>C | R | — | — | — | 40<br>A | 20 | 10 | Sr. M-B. Goller | |
| Heat and Light | C | 35<br>C | 35<br>C | 35<br>C | 70<br>P | — | 175<br>A | 20 | 10 | Sr. M-B. Goller | |

3. *Legend*

| | | |
|---|---|---|
| A: African. | E: European. | AD: Adaptation of published programmes by permission. |
| C: Completed. | R: Revising. | PA: Probably abandoned. |
| P: Proceeding | S: Seminar participants. | CA: Coloured and Asian. |

Table 51. Development of programmes

| TITLE | EDITIONS | | | | | Technical Rept. Nos. | Total pupils tested so far | Pages ? | Age group: years | AUTHOR(S) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Write 1–2 | 3 | Validate and Revise 4 | 5 | 6 | | | | | | |
| Magnetism | C | 40<br>C | 100<br>C | R | — | — | 140<br>A | 20 | 10 | Sr. M-B. Goller | |
| The Apostrophe | C | 35<br>C | R | — | — | — | 35<br>E | 30 | 15 | A. M. O'Brien | |
| A Building Society | C | 10<br>C | R | — | — | — | 10<br>A | 30 | 21* | R. A. Davenport | S |
| Duties of a Cashier | C | 10<br>C | R | — | — | — | 10<br>A | 60 | 21* | R. A. Davenport | S |
| Introd. to Smallpox Vaccination | C | 31<br>C | R | — | — | — | 31<br>A | 7 | 21* | B. J. Baldachin<br>W. A. Fraser Ross | S |
| Napoleon | C | 96<br>C | — | — | — | — | 96<br>E | 30 | 16 | C. J. Lawless | |
| Grades | C | 38<br>C | — | — | — | — | 38<br>A | 21 | 21* | J. D. Jordan | S |
| Railway Telephones | C | — | — | — | — | — | E/A | 20 | 21* | G. W. Brown | S |
| Vacuum Brake System | C | 6<br>P | — | — | — | — | 6<br>E/A | 20 | 21* | S. Kitley | S |
| Calculation of Mileages | C | — | — | — | — | — | E/A | 20 | 21* | J. Jones | S |
| Calculation of Local Fares | C | — | — | — | — | — | E/A | 20 | 21* | A. Howard | S |
| Ballast | C | — | — | — | — | — | E/A | 20 | 21* | W. Dempster | S |
| Day Shunting Hand Signals | C | — | — | — | — | — | E/A | 20 | 21* | G. Eldridge | S |

Table 51. Development of programmes

| TITLE | EDITIONS |  |  |  |  | Technical Rept. Nos. | Total pupils tested so far | Pages ? | Age group: years | AUTHOR(S) |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Write 1–2 | Validate and Revise 3 | 4 | 5 | 6 |  |  |  |  |  |  |
| Closing a Hydrostatic Lubricator | C | — | — | — | — | — | E/A | 14 | 21* | W. B. Scott | S |
| Automatic Vacuum Brakes | C | — | — | — | — | — | E/A | 20 | 21* | E. R. Welsh | S |
| D.E.2 Overspeed Governor | C | — | — | — | — | — | E/A | 15 | 21* | E. Ferreira | S |
| Preparing for Hand Firing | C | — | — | — | — | — | E/A | 30 | 21* | J. K. Plumb | S |
| 'Truck-Load' Livestock Charges | C | — | — | — | — | — | E/A | 20 | 21* | D. Cooper | S |
| Introduction to Induction | C | — | — | — | — | — | E/A | 50 | 30* | M. H. Knott | S |
| La Deuxieme Republique | C | 96<br>P | — | — | — | 20 | 96<br>E | 26 | 15 | C. J. Lawless |  |
| Decimal Fractions | C | 30<br>P | — | — | — | 19 | 30<br>E | 67 | 12 | J. R. Richards |  |
| Number Bases and Binary Arithmetic | AD | 40<br>P | — | — | — | — | 40<br>E/A | 67 | 14 | Learning Incorporated (Ad. D. G. Hawkridge) |  |
| Difficulties in English | C | 25<br>C | R | — | — | — | 25<br>CA | 33 | 16 | N. Padayachee |  |
| Family Relationships in English | C | P | — | — | — | — | A | 30 | 14 | S. Nondo |  |
| Biostatistics | C | 100<br>C | — | — | — | — | 100<br>E/A | 100 | 22 | W. Castle |  |

NOTES: 1. About 25 other programmes are still in the first writing edition. Topics included are from various school subjects and widely varying industrial and commercial training areas.
2. About 2,500 school-pupils and adults have been involved in testing to date. The former have been from about 20 schools in Rhodesia and Zambia.
3. For legend see page 53.

2

## APPENDIX

### CATALOGUE OF HOLDINGS IN THE PROGRAMMED LEARNING CENTRE AT THE UNIVERSITY COLLEGE OF RHODESIA, as at October 15th, 1966:

*Note*: Items marked (D) have been donated by organisations and individuals. All other items have been purchased through the assistance of a U.N. Special Fund subvention administered through U.N.E.S.C.O.

**Section A: Machines and Devices**

| No. | Machine | | Manufacturer | Electrical /Manual |
|---|---|---|---|---|
| 1 | Lamson Empirical Tutor Mark II (with two punch units) | | Lamson Technical Products, Herne Bay, England | E |
| 1 | U.S.I. Autotutor (on loan) | | U.S. Industries, London | E |
| 1 | ESATutor | | Educational Supply Assn., Harlow, England | M |
| 1 | Min/Max III | | Teaching Materials Corp., New York | M |
| 5 | Grundymasters | | International Teaching Machines, London | M |
| 35 | Lamson Programme Boards | | Lamson Technical Products (see above) | M |
| 1 | Hillborough | (D) | Lamson Technical Products (see above) | M |
| 1 | Haightutor | (D) | J. Haigh, England | M |
| 1 | Flashwheel | (D) | Spear's Games, England | M |
| 1 | Univox 'Teaching Machine' | | Universal Electronics Labs., New York | M |
| 10 | Cenco Learners | | Central Scientific Co., Chicago | M |

**Section B: Programmes for Machines and Devices**

| Machine | Programmes | Linear/ Branching |
|---|---|---|
| Lamson Empirical Tutor | The Lamson Empirical Tutor: an explanatory programme (written at the University College) | Modified Linear |
| Autotutor | Electronics (11 films; on loan) | Branching |
| ESATutor | The European Common Market | Linear |
| Min/Max III | Introductory statistics | ,, |
| | Physiology | ,, |
| | Chemistry | ,, |
| | Sound, light, electricity and communications | ,, |
| | Work and machines | ,, |
| | Biology and chemistry | ,, |
| | Electricity (D.C.) | ,, |
| | Measurement, meteorology and astronomy | ,, |
| | Time telling | ,, |
| | Number | ,, |
| | Addition and subtraction | ,, |
| | Multiplication and division | ,, |
| | Decimal numbers | ,, |
| | Fractions | ,, |
| | Modern maths: Introduction to numbers | ,, |
| | Modern maths: Number systems | ,, |
| | Algebra refresher | ,, |
| Min/Max III | Algebra I | Linear |
| | Algebra II | ,, |
| | Spelling | ,, |
| | Punctuation | ,, |
| Grundymaster | Nil (machine can take Centre programmes if required) | ,, |
| Lamson Programme Board | (ditto) | ,, |
| Hillborough | (ditto) | ,, |
| Haightutor | Starting arithmetic | ,, |
| Flashwheel | Addition | ,, |
| Univox Teaching Machine | Geography of the United States | ,, |
| Cenco Learners | Science 1 | ,, |
| | Science 2 | ,, |
| | English 1 | ,, |
| | English 2 | ,, |
| | Algebra 1 | ,, |
| | Arithmetic 1 | ,, |
| | Arithmetic 2 | ,, |
| | Vocabulary Building 1 | ,, |
| | Vocabulary Building 2 | ,, |
| | Spelling Demonstration 1 | ,, |
| | Spelling Demonstration 2 | ,, |

## Section C: Programmed Texts

| Publisher | Title |
|---|---|
| (1) English in School and Elsewhere | |
| Coronet Instructional Films, Chicago | Figures of speech<br>Vocabulary growth<br>Your study skills (2 copies) (D)<br>How to research and write a report (2 copies) (D)<br>How to improve your reading (2 copies) (D)<br>David discovers the dictionary (D) |
| Denver Public Schools, Denver | Forming plurals of nouns |
| Educational Developmental Laboratories, New York | Word clues: books G-M |
| Encyclopaedia Britannica, New York | Language experiences in reading (3 vols. plus manual)<br>Structure of poetry |
| Gibson, Glasgow | Self-correction English |
| Ginn, Boston | Writing: unit lessons in composition (3 vols.) (D)<br>By myself (D)<br>A programmed approach to writing (D) |
| Graflex, Rochester | Use of the dictionary guide words (2 copies plus manuals) |
| Harcourt, Brace, New York | English 3200<br>English 2600 |
| Inadcon, Burnham | English grammar (D)<br>Spelling and comprehension (D) |
| Heath, Boston | Programmed introduction to linguistics |
| Learning Inc., Scottsdale | Using the comma (D)<br>Synonyms, antonyms and homonyms (D)<br>Patterns in poetry (D) |
| McGraw-Hill, New York | Spelling improvement<br>Programmed reading (complete series plus ancillaries) |
| Macmillan, New York | English 900 (6 vols., plus 6 workbooks, plus manual) (D)<br>Learning to use the dictionary (plus manual)<br>Programmed English (plus manual) |
| Methuen, London | Senior spelling (2 copies) (D) |
| Science Research Associates | Words (2 copies) (D) |
| (2) Geography | |
| Coronet Instructional Films, Chicago | Westward expansion of our nation (2 copies) (D)<br>How we forecast the weather<br>Maps, how to read them<br>Latitude and longitude<br>Our solar system |
| Encyclopaedia Britannica, New York | Meteorology (plus manual) (D)<br>World affairs workshop (non-programmed, 10 vols. plus manual) (D) |
| Ginn, Boston | Earth-sun relations (plus manual) (D) |
| Graflex, Rochester | Using cloud appearances to predict weather<br>Our earth and the universe (2 copies)<br>Shaping the earth's surface (2 copies) |
| Holt, Rinehart and Winston, New York | South-east Asia |
| Learning Inc., Scottsdale | Our two newest states (D) |
| McGraw-Hill, New York | Reading latitude from maps |
| Macmillan, London | Programmed geography (3 vols. plus manuals) (D) |
| Methuen, London | The earth in orbit (D)<br>Climate geography (D) |
| Sutherland Education Committee, Brora | Economic geography of the British Isles (plus atlas) (D) |
| (3) Languages other than English | |
| Australian Council for Educational Research, Hawthorn | Lessons in intermediate Latin |
| Encyclopaedia Britannica, New York | Preparing for French |
| Inadcon, Burnham | Lessons in Latin (D) |
| Methuen, London | Middle school French (D)<br>A programmed German grammar (2 vols. 2 copies of vol. 1) (D) |
| TMI-Grolier, New York | Basic German reading |
| University of Akron, Akron | Revisions of the ALLP French program (D) |

## Section C: Programmed Texts

| Publisher | Title |
|---|---|
| (4) MATHEMATICS | |
| Allyn and Bacon, Boston | Decimals and percents |
| American Institute for Research, Pittsburgh | English money (D) |
| Chiang, Taiwan | Experiments in geometry (in Chinese) (2 copies) (D) |
| Coronet Instructional Films, Chicago | Number bases and binary arithmetic |
| | Understanding problems in arithmetic (2 copies) |
| Cuisenaire of America, New York | Mathematical awareness (2 manuals) (D) (non-programmed) |
| Doubleday, New York | Adventures in algebra |
| | The slide rule |
| | Fractions |
| Encyclopaedia Britannica, New York | Introductory calculus (2 vols) |
| | Sets, inequalities and functions |
| | Whole numbers and numerals |
| | Arithmetic of whole numbers (3 vols.) |
| | Verbal problems in algebra |
| | Ratios and proportions (2 vols.) |
| | Preparing for algebra |
| | Algebra (2 year course, 12 vols.) |
| | Language of algebra: fields and ordered fields (2 vols.) |
| | Plane geometry (6 vols.) |
| | Analytic trigonometry (3 vols.) |
| | Trigonometry (3 vols.) |
| | Basic mathematics (3 vols.) |
| | Discovery in elementary school mathematics (non-programmed) (D) |
| | Math laboratory materials (guide, notes to teacher, teachers' guides, 6 vol. series of pupils' books, all non-programmed) (D) |
| English Universities Press, London | Adventures in algebra (D) |
| | Basic mathematics (D) |
| | Trigonometry (D) |
| | The arithmetic of computers (D) |
| Graflex, Rochester | Addition of fractions (plus manual) (2 copies) |
| | Introduction to probabilities (plus manual) (2 copies) |
| | Time telling (plus manual) (2 copies) |
| | Computing square roots (plus manual) (2 copies) |
| | Avogadro's number (plus manual) (D) |
| | Multiplication of numbers (plus manual) (D) |
| | Perimeters (plus manual) (D) |
| | Arithmetic facts (plus manual) (D) (2 vols.) |
| | Learning about fractions (plus manual) (D) |
| Ryksuniversiteit, Utrecht | Berekening van oppervlakten onder een parabool (2 vols.) |
| Harcourt, Brace, New York | Mathematics enrichment (2 vols.) |
| Holt, Rinehart and Winston, New York | A program in contemporary algebra |
| Inadcon, Burnham | Algebra (D) |
| | How to use logarithm tables (D) |
| Learning Inc., Scottsdale | Division by zero—impossible? (D) |
| Longmans, London | A first book of sets (2 copies) (D) |
| | The geometry of the point and line (D) |
| Macmillan, New York | Understanding modern mathematics (5 vols.) |
| McGraw-Hill, New York | Introduction to multiplication |
| | Groups and fields |
| | Sets, relations and functions (plus 2 copies of manual) |
| | Introduction to Boolean algebra |
| | Logarithms self-taught |
| | Trigonometry self-taught |
| | Numeration systems and scientific notations |
| Methuen, London | Triangles (D) |
| | Angles (D) |
| | Areas of rectangles (D) |
| | Logarithms (2 copies) (D) |
| | Brackets (D) |
| | Fractions (D) |
| National Institute for Personnel Research, Johannesburg | Introduction to algebra: simple equations (lesson 1a only, 2 copies) |

**Section C: Programmed Texts**

| Publisher | Title |
|---|---|
| Science Research Associates, Chicago | Modern mathematics (10 vols.) |
| Teaching Programmes, Bristol | Basic principles of digital computers (D)<br>Factors (2 copies) (D) |
| Training Systems, Los Angeles | Solving simple algebraic equations |
| University of Keele, Keele | Logarithms revisited |
| University of Illinois, Urbana | UICSM materials for self instruction<br>Experimental programed materials in high school mathematics (D)<br>High school mathematics Part 102 (D)<br>Geometry for charting the universe (D)<br>Introduction to fractions (D) |
| Wiley, New York | Programmed beginning algebra (5 vols. plus manual)<br>A programmed introduction to vectors (D) |
| (5) SCIENCE | |
| Australian Council for Educational Research, Hawthorn | Extraction of metals (D)<br>Formulae (D)<br>An approach to Redox reactions (D)<br>An approach to ionic equations (D) |
| Central Scientific Co., Chicago | Hydrostatics |
| Coronet Instructional Films, Chicago | Cells<br>How scientists think and work (2 copies) (D)<br>Chemistry concepts<br>Grouping animals<br>Your heart and circulation (2 copies) (D) |
| Encyclopaedia Britannica, Chicago | The human body and its functions (2 copies)<br>Biology: the evolution of life (D)<br>Mechanics (plus manual) (D)<br>Chemistry (plus manual) (D)<br>Engines (plus manual) (D)<br>Sound and light (plus manual) (D) |
| English Universities Press, London | Calorimetry, conductivity and gas laws (D)<br>Introduction to electronics (D)<br>Nomenclature of aliphatic compounds (D)<br>Chemistry of carbon and some of its compounds (D)<br>Introduction to heat (D)<br>Mineral acids and their derivatives: the chemistry of sulphur, chlorine and nitrogen (D) |
| Graflex, Rochester | Asexual reproduction in plants (2 copies)<br>The mole concept in chemistry (2 copies)<br>An introduction to entomology<br>Trees<br>Classification of plants<br>Life cycle of insects<br>Levers (D) |
| Holt, Rinehart and Winston, New York | Kinetic and molecular theory of gases<br>Gases: gas laws |
| Inadcon, Burnham | Asexual reproduction of plants (D) |
| Learning Inc., Scottsdale | Chemistry concepts, the molar method (D)<br>Photosynthesis<br>Flower parts<br>Experiments with sound<br>The biggest reptiles (D) |
| McGraw-Hill, New York | Programmed astronomy (2 vols. plus manuals) |
| Macmillan, New York | Energy and work (4 vols. plus manuals) (30 copies mixed, some D) |
| Methuen, London | Mass, weight and density (D)<br>Kinematics (D) |
| Ohio State University, Columbus | Kinetic theory of gases |
| Rider, New York | Gyro fundamentals<br>Simplified transistor theory (D)<br>D.C. circuit principles (D) |
| Science Research Associates | How to use the microscope (3 vols.)<br>Matter and atomic structure<br>Earth's atmosphere laboratory (non-programmed) |
| Sutherland Education Committee, Brora | Structure of the atom (D) |
| Varian Associates, Palo Alto | Klystrons |
| Wiley, New York | Fundamental physics (plus conventional text) |

**Section C: Programmed Texts**

| Publisher | Title |
|---|---|
| **(6) MEDICINE** | |
| Basic Systems, New York | Clinical pharmacology (D) |
| | A programmed course in electrocardiography Part I (D) |
| | Correcting common errors in blood pressure measurement (D) |
| | Anxiety recognition and intervention (D) |
| Crookes Laboratories, Basingstoke | The endocrinology, diagnosis and treatment of gynaecological diseases (4 vols.) |
| English Universities Press, London | Electrocardiography |
| Heath, Boston | Programmed genetics (vol. 1) |
| McGraw-Hill, New York | An introduction to genetics (50 copies) |
| Macmillan, New York | Programmed mathematics for nurses (2 copies) |
| Ortho Pharmaceuticals, New York | Methods of conception control (D) |
| Royal College of Nursing, Birmingham | Eyes (D) |
| | Food and the physiology of the alimentary tract (2 copies) (D) |
| | Blood groups (D) |
| | Anatomy and physiology (D) |
| Siemens-Reiniger-Werke, Erlangen | Programmed instruction on grid ratio (D) |
| Pfizer, New York | Allergy and hypersensitivity (10 copies) (D) |
| | Physicians' liability for battery, negligence and acts of others (D) |
| | Current concepts of thyroid disease (27 copies) (D) |
| United States Dept. of Health, Communicable Diseases Center, Atlanta | Jet injector operation: model K3 |
| | Jet injector daily maintenance and repair: model K3 (2 copies plus manual) (D) |
| | Insecticide formulation (D) |
| | Personnel procedures for General Schedule positions (plus manual) (D) |
| University of Illinois, Urbana | Anatomy of the trigeminal nerve: Forms B, C and E (D) |
| Wiley, New York | Medical terminology |
| **(7) PSYCHOLOGY AND RELATED FIELDS** | |
| Addison-Wesley, Reading | Physiological psychology |
| Encyclopaedia Britannica, Chicago | Introductory descriptive statistics |
| Harcourt, Brace, New York | Handbook to Hilgard's 'Introduction to Psychology' |
| McGraw-Hill, New York | The analysis of behavior |
| | Statistical concepts (2 copies plus manual) |
| TMI-Grolier, New York | Introductory statistics (4 copies) (A further 25 copies are held by the Faculty of Medicine for use in the Biostatistics course) |
| United States Dept. of Health, Communicable Diseases Center, Atlanta | Lecture preparation guide (plus manual) (D) |
| University of Illinois | Common elements program for the card array task |
| Wiley, New York | Descriptive statistics |
| **(8) BUSINESS AND INDUSTRIAL EDUCATION** | |
| Addison-Wesley, Reading | Basic supervision of people (D) |
| | Essentials of note teller collections (D) |
| | Essentials of accounting (D) |
| Anglo-American Corporation, Johannesburg | The miner's daily duties (D) |
| | Use of steel rods in support (D) |
| | The sandana device (D) |
| | The scraper rigs to be used with the 2P2SC system (D) |
| | The scatter barricade (D) |
| | Procedures on the cleaning shift (D) |
| | The drilling shift (D) |
| | The 2P2SC system of stoping (D) |
| | Method of re-entry examination and making safe (D) |
| | Blasting operations (D) |
| | Stoping through faults (D) |
| | Drilling strike gulliers (D) |
| | The use of the stope gang (D) |
| | Allocation and correct utilisation of labour for the 2P2SC system (D) |
| | Stope support (D) |
| | The stope drill jig (D) |
| | Complete procedure over a shift (D) |

## Section C: Programmed Texts

| Publisher | Title |
|---|---|
| (8) BUSINESS AND INDUSTRIAL EDUCATION | |
| | Air and water services and ventilation screening (D)<br>Methane precautions (series of 12 vols.) (D) |
| Argyle, New York | Cutting office costs through work simplification<br>Understanding public relations<br>Methods improvement |
| Collier-Macmillan, London | Theory of income determination (plus workbook) (D)<br>Supply and demand (plus workbook) (D) |
| Douglas Aircraft, Long Beach | Why system engineering and system functional analysis for total system design? |
| Educational Methods, Chicago | Essentials of the bank teller's job |
| Encyclopaedia Britannica, New York | Beginning Bookkeeping<br>Mathematical bases for management decision making (2 vols.) (D) |
| English Universities Press, London | Accounting step by step (3 vols.) (D)<br>How to write a business letter (D) |
| Graflex, Rochester | Forms of business organisation (plus manual) (D) |
| Hamilton Research Associates, Maryland | How to read the official airline guide |
| Learning Inc., Scottsdale | Sales training (D)<br>How to get along with your bank statement (D) |
| McGraw-Hill, New York | How to follow the stock market (D)<br>Programmed blueprint reading (4 vols.)<br>The accounting process (plus 3 manuals)<br>Effective letters in business<br>Programmed business mathematics (4 vols.) |
| Shell International, London | Gasoline (2 vols.) (D)<br>Oils (2 vols.) (D) |
| Sutherland Education Committee, Brora | Free trade (D) |
| University of Sheffield | Tensile testing (D) |
| ???? | Tolerances, gauging and limit gauges (D) |
| (9) MISCELLANEOUS | |
| Coronet Instructional Films, Chicago | The Bill of Rights (2 copies) (D)<br>Choosing your career (2 copies) (D) |
| Encyclopaedia Britannica, New York | Musical notation<br>Interior decoration |
| English Universities Press, London | The elements of bridge (D) |
| Graflex, Rochester | Elementary color (2 copies, plus manuals) |
| Learning Inc., Scottsdale | Music makers (D)<br>The members of Congress (D)<br>Roller skating safety (D) |
| McGraw-Hill, New York | Fundamentals of music<br>Melodic perception (plus manual but without records) (D) |
| Methuen, London | The Waterloo campaign (D)<br>The battle of Hastings (D) |
| Sutherland Education Committee, Brora | Government of the U.S.A. (D) |
| University of Illinois, Urbana | Culture assimilator: I Arab culture (2 vols.) (D) |

## Section D: Texts on Progamming and Larger Research Reports

| | |
|---|---|
| Angell, D. and Lumsdaine, A. A. | Research on cueing factors related to programed instruction.<br>San Mateo, American Institute for Research, 1962. (D) |
| Angell, D. and Lumsdaine, A. A. | A study of subject controlled partial cueing in paired-associate learning.<br>San Mateo, American Institute for Research, 1961. (D) |
| Austwick, K. | Teaching machines and programming.<br>Oxford, Pergamon, 1964. |
| Austwick, K. | Programming '64.<br>Sheffield, Dept. of Education of Sheffield University, 1964 (D) |
| Austwick, K. | Programmed learning: a study of the nature, scope and limitations of a new educational medium for member states of the organisation: a report prepared for the Directorate of Scientific Affairs, the Organization for Economic Cooperation and Development.<br>London, the Organization, 1965. (D) |
| Barnett, W. G. and Proctor, L. | Automation in education.<br>Johannesburg, College of Education, 1963. (D) |
| Basic Systems Inc. | Introduction to programed instruction. |

| | |
|---|---|
| | New York, the Company, 1965. (D) |
| Becker, J. L. | A programed guide to writing auto-instructional programs.<br>Camden, Radio Corporation of America, 1964. |
| Berliner, D. C. *et al* | Memory span and self-direction in serial learning of names.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Berliner, D. C. *et al* | Behaviors, measures and instruments for performance evaluation in simulated environments.<br>Palo Alto, American Institute for Research, 1964. (D) |
| Birney, R. and Teevan, L. | Reinforcement.<br>Princeton, Van Nostrand, 1961. |
| Bivens, L. W. *et al* | Self-direction in programed instruction: effects on learning in low ability students.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Brooks, L. O. | Shaping faster question answering.<br>Palo Alto, American Institute for Research, 1965. (D) |
| Burton, B. B. and Goldbeck, R. A. | The effect of response characteristics and multiple-choice alternatives on learning during programed instruction.<br>San Mateo, American Institute for Research, 1962. (D) |
| Campbell, V. N. | Studies of bypassing as a way of adapting self-instruction programs to individual differences.<br>San Mateo, American Institute for Research, 1962. (D) |
| Campbell, V. N. | Learning: from R-M theory to educational planning.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Campbell, V. N. | Self-direction and programmed instruction for five different types of learning objectives.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Campbell, V. N. and Bivens, L. W. | Self-direction in programed geography instruction.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Campbell, V. N. *et al* | Effects of mathematical ability on pretraining and interest on self-direction in programed instruction.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Coulson, J. | Programed learning and computer-based instruction.<br>New York, Wiley, 1962. |
| Cram, D. | Explaining teaching machines and programing.<br>San Francisco, Fearon, 1962. |
| Davey, D. M. and McDonnell, P. | Programmed instruction.<br>London, Institute for Personnel Management, 1964. (D) |
| Davis, D. J. | The effects of sequence and structure on complex concept formation.<br>University of Illinois, Urbana, 1964. (D) |
| Davis, D. J. | An examination of human strategies for acquiring information.<br>University of Illinois, Urbana, 1965. (D) |
| De Cecco, J. (ed.) | Educational technology.<br>New York, Holt, Rinehart and Winston, 1964. |
| Deterline, W. A. | An introduction to programed instruction.<br>Englewood Cliffs, Prentice-Hall, 1962. |
| Dodd, B. (ed.) | Programming '63.<br>Sheffield, Dept. of Education of Sheffield University, 1963. (D) |
| Duke, B. C. (ed.) | Survey of educational media research in the Far East.<br>Washington, D.C., Department of Health, Education and Welfare, 1963. (D) |
| Edling, J. V. *et al* | Four case studies of programed instruction.<br>New York, Fund for the Advancement of Education, 1964. (5 copies) (D) |
| Epstein, S. | The first book of teaching machines.<br>New York, Franklin Watts, 1961. |
| Filep, R. T. | Prospectives in programming.<br>New York, Collier-Macmillan, 1964. |
| Fine, B. | Teaching machines.<br>New York, Sterling, 1962. |
| Frase, L. T. | The effect of social reinforcers in a programed learning task.<br>Urbana, University of Illinois, 1963. (D) |
| Fry, E. | Teaching machines and programming.<br>New York, McGraw-Hill, 1963. |
| Galanter, E. | Automatic teaching: the state of the art.<br>New York, Wiley, 1959. (2 copies) |
| Gillespie, J. F. *et al* (eds.) | Proceedings of the programed instruction institute presented by the N.S.P.I., San Antonio, April 1962.<br>San Antonio, the Society, 1963. (D) |
| Goldbeck, R. A. *et al* | Further experimental evidence on response modes in automated instruction.<br>Santa Barbara, American Institute for Research, 1960. (D) |
| Goldsmith, M. (ed.) | Mechanisation in the classroom.<br>New York, Souvenir Press, 1963. |
| Goodman, R. | Programmed learning and teaching machines. (2nd ed.)<br>London, English Universities Press, 1964. (3 copies) |

## Section D: Texts on Programming and Larger Research Reports

| | |
|---|---|
| Green, E. J. | The learning process and programed instruction.<br>New York, Holt, Rinehart and Winston, 1962. |
| Hamilton, N. R. | Increasing long-term retention of knowledge: experiment I.<br>Palo Alto, American Institute for Research, 1965. |
| Hamilton, N. R. and Porteus, B. D. | Increasing long-term retention of knowledge: experiment II.<br>Palo Alto, American Institute for Research, 1965. (D) |
| Hanson, L. F. (ed.) | The use of programed instruction in U.S. Schools.<br>Washington, D.C., Dept. of Health, Education and Welfare, 1963. (D) |
| Hershberger, W. | Learning via programed reading, and cue versus response in programed reading.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Hershberger, W. | Distinguishing errors of memory from errors of understanding by means of self-instructional tests.<br>Palo Alto, American Institute for Research, 1964. (D) |
| Hershberger, W. and Terry, D. F. | Complexity of typographical cueing in programed and conventional texts.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Hershberger, W. and Terry, D. F. | Delay of self-testing in three types of programed text.<br>Palo Alto, American Institute for Research, 1964. (D) |
| Hoban, C. F. *et al* | Newer educational media.<br>Washington, D.C., Dept. of Health, Education and Welfare, 1961. (D) |
| Holland, J. G. and Skinner, B. F. (eds.) | An analysis of the behavioral process involved in self-instruction with teaching machines.<br>Cambridge, Harvard University, 1965. (D) |
| Holtz, H. R. and Alter, P. A. | A short course in intrinsic programing.<br>Silver Spring, U.S. Industries Educational Science Division, 1965. (D) |
| Hughes, J. L. | Programed instruction for schools and industry.<br>Chicago, Science Research Associates, 1962. |
| Kay, H., *et al.* | Teaching machines and their use in industry.<br>London, H.M.S.O., 1963. (2 copies) |
| Keeves, J. P. | A review of programmed instruction.<br>Melbourne, Australian Council for Educational Research, 1962. (D) |
| Keislar, E. R. *et al.* | Sequence of listening and speaking in beginning French.<br>Los Angeles, University of California, 1965. (D) |
| Lawrence, J. and Festinger, R. | Deterrents and reinforcements.<br>London, Tavistock, 1962. |
| Leedham, J. F. | The use of programmed material and teaching machines for primary education.<br>Leicester, University of Leicester, 1965. (D) |
| Leith, G. O. M. *et al.* | A handbook of programmed learning.<br>Birmingham, University of Birmingham, 1964. (D) |
| Lumsdaine, A. A. and Glaser, R. | Teaching machines and programmed learning: a source book.<br>Washington, D.C., National Education Association, 1960. |
| Lysaught, J. P. (ed.) | Programmed learning: evolving principles and applications.<br>Ann Arbor, Foundation for Research on Human Behavior, 1964. (D) |
| Lysaught, J. P. and Williams, C. M. | A guide to programed instruction.<br>New York, Wiley, 1963. |
| McHale, T. J. and Stolurow, L. M. | More information—cues or principle?<br>Urbana, University of Illinois, 1964. (D) |
| Margulies, S. and Eigen, L. D. | Applied programed instruction.<br>New York, Wiley, 1962. |
| Markle, S. M. | Good frames and bad.<br>New York, Wiley, 1964. |
| Markle, S. M. *et al.* | The compleat programer.<br>Chicago, University of Illinois, 1965. (D) |
| Markle, S. M. *et al.* | A programed primer on programing.<br>New York, Center for Programed Instruction, 1961. (3 copies) |
| Mechner, F. | Science, education and behavioral technology.<br>New York, Basic Systems Inc. 1963. (D) |
| Mechner, F. and Cook, D. A. | Behavioral technology and manpower development.<br>New York, Basic Systems Inc., 1963. (D) |
| Mills, A. L. (ed.) | Programed learning and the educational process.<br>New York, Thomas Alva Edison Foundation, 1961. (D) (2 copies) |
| Milton, O., and West, L. J. | Programed instruction: what it is and how it works.<br>New York, Harcourt, Brace, 1961. |
| Montagnon, P. and Bennett, R. (eds.) | What is programmed learning?<br>London, BBC Publications, 1965. (D) |
| Morgan, R. M. and Branson, R. K. | Programed instruction: a concept of learning.<br>Palo Alto, General Programed Teaching Corp., 1964. (2 copies) (D) |
| Mouly, G. J. and Walton, L. E. | Test items in education.<br>New York, Schaum, 1962. |
| National Committee for Audio-visual Aids in Education | Some aspects of programmed learning: a symposium.<br>London, the Committee, 1963. |

**Section D: Texts on Programming and Larger Research Reports**

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|---|---|
| Ofeish, G. D. and<br>Meierhenry, W. C. (eds.) | Trends in programed instruction: papers from the first annual convention of the N.S.P.I., San Antonio, April 1962.<br>San Antonio, the Society, 1964. (D) |
| Pask, G. | An approach to cybernetics.<br>London, Hutchinson, 1961. |
| Peel, E. A. *et al.* (eds.) | Educational Review Vol. 16, 2, 1964 (special issue).<br>Birmingham, University of Birmingham, 1964. (D) |
| Schramm, W. (ed.) | The research on programed instruction.<br>Washington, D.C., Dept. of Health, Education and Welfare, 1964. (2 copies) (D) |
| Shearer, J. W. | Long-term retention of social science material presented by programed and conventional methods.<br>Palo Alto, American Institute for Research, 1963. (D) |
| Skinner, B. F. | Verbal behavior.<br>New York, Appleton-Century-Crofts, 1957. |
| Skinner, B. F. | Cumulative record.<br>New York, Appleton-Century-Crofts, 1959. |
| Smith, M. D. | Fundamentals of programing for teaching machines and programed texts.<br>Richmond, Earlham College, 1961. (D) |
| Smith, W. I. and<br>Moore, J. W. | Programed learning.<br>Princeton, Van Nostrand, 1962. |
| Stolurow, L. M. | Teaching by machine.<br>Washington, D.C., Dept. of Health, Education and Welfare, 1961. |
| Stolurow, L. M. (ed.) | Psychological and educational factors in transfer of training: quarterly reports nos. 5-9.<br>Urbana, University of Illinois, 1963-4. (D) |
| Thomas, C. A. *et al.* | Programmed learning in perspective.<br>London, City Publicity Services, 1963. |
| Walther, R. E. and<br>Crowder, N. | A guide to preparing intrinsically programed instructional materials.<br>Silver Spring, U.S. Industries, 1963. (D) |
| Wiley, John and Sons | A guide to Wiley authors in the preparation of linear auto-instructional programs.<br>New York, Wiley, 1961. |

**Section E: Periodicals**

Association for Programmed Instruction Newsletter (Australia)
- No. 3—December 1964
- No. 4—March 1965

Association for Programmed Learning Newsletter (England)
- No. 2—May 1963
- No. 5—December 1963
- No. 6—March 1964
- No. 7—May 1964
- No. 9—November 1964
- No. 10—February 1965
- No. 11—March 1965
- No. 12—June 1965
- No. 13—October 1965
- No. 14—January 1966
- No. 15—March 1966
- No. 16—June 1966
- No. 17—August 1966

Association for Programmed Learning Bulletin (England)
- No. 3—February 1963

Bulletin on the Progress of Programmed Learning in Bournemouth
- No. 4—Spring Term 1965
- No. 5—Summer Term 1965 (2)
- No. 6—Autumn Term 1965

Bulletin of the Glasgow University Programmed Learning Research Unit
- No. 1—October 1964
- No. 2—January 1965
- No. 3—April 1965
- No. 4—July 1965
- No. 5—October 1965
- No. 6—January 1966
- No. 7—April 1966
- No. 8—July 1966

College of Preceptors Programmed Learning Reports
- No. 1—March 1964
- No. 2—September 1964
- No. 3—October 1965.

Information Bulletin Concerning Programmed Learning Research in Central Africa
- Vol. 1, Nos. 1-4
- Vol. 2, Nos. 1-4
- Vol. 3, Nos. 1-4

National Society of Programed Instruction Journal (U.S.A.)—N.S.P.I.
- Vol. 4, Nos. 1-10
- Vol. 5, Nos. 1-7

Programed Instruction (CPI Bulletin) (U.S.A.)
- Vol. 1, Nos. 1-4 and 6
- Vol. 2, Nos. 3, 5 and 6
- Vol. 3, Nos. 1-8
- Vol. 4, Nos. 1-7 and 9
- Vol. 5, Nos. 1-4

Journal of the Association for Programmed Learning (England)
- Vol. 1, Nos. 1-3
- Vol. 2, Nos. 1, 2
- Vol. 3, Nos. 1, 2

Review of the Leicestershire & District Programmed Learning Group
- Vol. 1, No. 1
- Vol. 2, No. 1
- Vol. 3, Nos. 1-2

### Section E: Periodicals

Tutorage (England)
No. 10—August 1964
No. 11—November 1964
No. 12—March 1965
No. 13—July 1965
No. 14—November 1965
No. 15—Spring 1966
No. 16—Summer 1966

Bulletin of the University of Rochester School of Medicine
Vol. 1, No. 2—July 1966

Newsletter of the National Society for Programed Instruction (Boston)
Vol. 2, Nos. 1, 3-5

Phillips Education Papers
Vol. 1, No. 1—December 1965

Programed Learning Bulletin of the University of Michigan
Vol. 1, No. 4
Vol. 2, Nos. 1-4

Programmed Instruction Bulletin (A.P.I., Australia)
Vol. 1, No. 1—October 1965
Vol. 2, No. 2—May 1966

The Journal of Programed Instruction
Vol. 3, Nos. 1-4

Training Newsletter (Shell International)
No. 10—January 1966

### Section F: Commercial Information

Data from the following commercial organisations is on file:

| | |
|---|---|
| Addison-Wesley Publishing Co. Inc. | Publishers of programmed texts |
| Allyn and Bacon Inc. | Publishers of programmed texts |
| American Management Association Inc. | Sponsors of programming |
| Argyle Publishing Corp. | Publishers of programmed texts |
| Basic Systems Inc. | Programmers and publishers of programmed texts |
| Behavioral Research Laboratories | Programmers and publishers of programmed texts |
| Central Scientific Co. (Cenco) | Manufacturers of teaching machines and programmers |
| Center for Programmed Learning for Business (University of Michigan) | Programmers and programmer trainers |
| Collier-Macmillan Ltd. | Publishers of programmed texts |
| Coronet Instructional Films Inc. | Publishers of programmed texts |
| Dillon's University Bookshop | Booksellers |
| Education and Training Consultants | Programmers and publishers of research material |
| Educational Development Corp. | Manufacturers of teaching machines |
| Educational Methods Inc. | Programmers and publishers of programmed texts |
| Educational Research Associates | Manufacturers of teaching machines |
| Educational & Scientific Dev. Ltd. | Programmers, publishers of programmed texts, and manufacturers of teaching machines |
| Electronic Properties International | Manufacturers of teaching machines |
| General Programmed Teaching Corp. | Programmers |
| Graflex Inc. | Programmers and publishers of programmed texts |
| Heath & Co. | Publishers of programmed texts |
| Heinemann Technical Books | Publishers of programmed texts |
| Human Development Institute Inc. | Programmers |
| International Advisory Consultants (Inadcon) | Programmers and publishers of programmed texts |
| Lamson Technical Products | Formerly manufacturers of teaching machines and devices |
| Longmans Ltd. | Publishers of programmed texts |
| Macalaster Scientific Corp. | Manufacturers of teaching machines |
| Macmillan Co. | Publishers of programmed texts |
| Mast Development Co. | Manufacturers of teaching machines |
| McGraw-Hill Inc. | Publishers of programmed texts |
| Methuen Ltd. | Publishers of programmed texts |
| Noble and Noble | Formerly publishers of programmed texts |
| Oliver and Boyd Ltd. | Publishers of programmed texts |
| Packman Research Ltd. | Manufacturers of teaching machines |
| Pergamon Press Ltd. | Publishers of programmed texts |
| Philips N. V. | Manufacturers of teaching machines |
| Pretoria Study Aids | Booksellers |
| Saunders and Co. | Publishers of programmed texts |
| Teaching Materials Corporation-Grolier | Formerly manufacturers of teaching machines and publishers of programmed texts |
| TECO Instruction Inc. | Programmers |
| Title Insurance Co. | Programmers and publishers of programmed texts |

### Section F: Commercial Information

| | |
|---|---|
| United States Department of Health Communicable Diseases Center | Programmers and publishers of programmed texts |
| U.S. Industries Inc. | Programmers and manufacturers of teaching machines |
| Universal Electronics Laboratories | Formerly publishers of programmed texts |
| Varian Associates | Formerly programmers and publishers of programmed texts |
| Videosonic Systems | Manufacturers of teaching machines |
| Vimcet | Programmers |
| Westinghouse Electric Corporation | Programmers |
| Wiley and Son | Publishers of programmed texts |

### Section G: Research Reports

All items on this list have been donated by organisations or individuals, or received in exchange for materials sent out by the Centre.

All abbreviations used below to describe periodicals are those used in the World List of Scientific Periodicals 4th edition, 1963, if the periodicals are in that list. The remainder will mostly be found in Ulrich's Periodicals Directory, 10th edition, 1963. The standardized form for entering research reports from periodicals is:

| | |
|---|---|
| Annett, J. | Teaching machines.<br>*Reprinted from* Medical and Biological Illustration, 13, 1, Jan. 1963, pp. 38-43, bibliog. |

In this form the first figure refers to the volume, the second to the issue number. Full details have been included wherever available.

| | |
|---|---|
| Addison, R. R. and Homme, L. E. | The reinforcing event (RE) menu.<br>*Reprinted from* NSPI Journal, 5, 1, Jan. 1966, bibliog. |
| American Institutes for Research | A list of projects in the field of programmed instruction. |
| Angell, David and Lumsdaine, A. A. | A study of subject-controlled partial cueing in paired-associate learning.<br>San Mateo, American Institute for Research, Sept. 1961, bibliog. |
| Angell, David and Lumsdaine, A. A. | The effects of prompting trials and partial correction procedures on learning by anticipation.<br>San Mateo, American Institute for Research, Sept. 1961, bibliog. |
| Angell, David and Terry, D. F. | Response guidance, response-term similarity and test type in the learning and retention of word pairs.<br>San Mateo, American Institute for Research, Sept. 1962, bibliog. (2 copies) |
| Annett, J. | Teaching machines.<br>*Reprinted from* Medical and Biological Illustration, 13, 1, Jan. 1963, pp. 38-43, bibliog. |
| Annett, J. | The relationship between theories of learning and theories of instruction: a paper read to the Conference on Programmed Instruction and Teaching Machines (sic), Berlin, July 1963. Hull, the author, mimeo. |
| Annett, J. | Teaching machines: psychological questions and research issues; a paper read to the Scottish Branch of the British Psychological Society.<br>*Abstract from* Bull. Br. Psychol. Soc., 17, 55, 1964, p. 42. |
| Association for Programmed Learning | Programme evaluation questionaire.<br>Aberdeen, Association for Programmed Learning, 1964. |
| Association for Programmed Learning | National conference and exhibition handbook.<br>Leicester, Loughborough Training College, 1966. |
| Austwick, K. | Teaching machines.<br>*Reprinted from* University of Sheffield Gazette, 40, Mar. 1962, pp. 41-43. |
| Austwick, K. | Automated teaching.<br>*Reprinted from* Research, Lond., 15, Nov. 1962, pp. 477-482. |
| Balabian, N. | A learning program in engineering education.<br>*Reprinted from* J. Enging. Educ., 55, 2, 1964, pp. 46-49, bibliog. |
| Balabian, N. | The educational engineering called programed instruction.<br>Berkeley, University of California, 1965, bibliog. |
| Balabian, N. | The Programed Learning Project: a progress report.<br>*Reprinted from* J. Engineering Education, 58, 8, April 1966, pp. 305-308. |
| Banks, B. | Some enquiries into programming.<br>Tunbridge Wells, unpublished, 1964, mimeo. |
| Bitzer, D. L. *et al.* | The uses of PLATO: a computer controlled teaching machine.<br>Urbana, University of Illinois, Oct. 1965, bibliog. |
| Bivens, L. W. | Feedback complexity and self-direction in programmed instruction.<br>*Reprinted from* Psychol. Rep. 1964, pp. 155-160, bibliog. |
| Blyth, J. W. | Programed instruction in professional education.<br>New York, Argyle Publ. Co., n.d. |
| Brethower, D. M. | Learning theory.<br>Ann Arbor, University of Michigan, 1965. |
| Brethower, D. M. | An integration of mathetical, linear and branching techniques.<br>Ann Arbor, University of Michigan, n.d. |
| Briggs, L. J. *et al.* | Investigations of thinking via self-instructional programs.<br>Palo Alto, American Institutes for Research, June 1964. |

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|---|---|
| Briggs, L. J. *et al.* | Programed instruction in science and mathematics.<br>*Reprinted from* Rev. Ed. Research, 34, 3, June 1964, pp. 354-373, bibliog. |
| Briggs, L. J. *et al.* | Don't oil your teaching machine.<br>*Reprinted from* Psychol. Rep., 15, 1964, p. 350, bibliog. |
| Briggs, L. J. *et al.* | Meaningful learning and retention: practice and feeedback variables.<br>*Reprinted from* Rev. Ed. Research, 34, 5, Dec. 1964, pp. 545-558, bibliog. |
| Briggs, L. J. *et al.* | Instructional methods program.<br>Palo Alto, American Institutes for Research, 1965. |
| British Council | Programmed instruction in the United Kingdom: a survey by the educational aids department.<br>London, the Council, 1965, bibliog. |
| Bullock, D. and Rogers, J. | Computer training by programed instruction.<br>*Reprinted from* Data Processing for Management Magazine, July. 1963. |
| Buys, H. *et al.* | Reports to the Federal Ministry of Education regarding programmed learning.<br>Bulawayo & Salisbury, unpublished, 1963, photostat. |
| Calder, J. R. | Research in programmed learning in Aberdeen.<br>*Abstract from* Bull. Br. Psychol. Soc., 17, 55, 1964. |
| California, University of | Computer assisted instruction, 1966: types of training program.<br>Los Angeles, University of California, 1966. |
| Campbell, V. N. | Bypassing as a way of adapting self-instruction programs to individual differences.<br>*Reprinted from* J. educ. Psychol. 54, 6, 1963, pp. 337-345, bibliog. |
| Campbell, V. N. | Self-direction and programed instruction for five different types of learning objectives.<br>*Reprinted from* Psychology in the Schools, 1, 4, pp. 348-359, 1964, bibliog. |
| Campeau, P. L. | Level of anxiety and presence or absence of feedback in programed instruction.<br>Palo Alto, American Institutes for Research, 1965. |
| Canac, H. *et al.* | L'educateur devant la machine.<br>Numero special de L'Education Nationale, 15-16, April 1965,. |
| Carnegie Corporation | Not from teaching but from questioning.<br>*Reprinted from* Carn. Corp. Quarterly, Oct. 1961. |
| Carroll, J. B. | *Reviews:*<br>J. S. Holton: Sound language teaching.<br>F. Rand Morton *et al.:* Programming of audio-lingual skills for self-instructional presentation.<br>Fernand Marty: Programing a basic foreign language course: prospects for self-instruction.<br>Contemp. Psychol., 7, 1962, pp. 437-439. |
| Carroll, J. B. | What the foreign language teacher trainer or supervisor should know about programed instruction in the foreign language field: a paper prepared for the Foreign Language and Teacher Training Seminar, University of Washington, September, 1962.<br>Washington, unpublished, 1962, mimeo. |
| Cartier, F. A. | After the programming fad fades—then what?<br>The Melting Pot (Teachers College Bulawayo), Oct. 1963. |
| Cassell, R. N. and Ullom, W. U. | A preliminary evaluation of programed instruction with high ability students.<br>Lompoc, Lompoc Unified Schools, 1962. |
| Conference on Programmed Learning | Report of a conference held by the King Edward Hospital Fund for London, Sept. 29, 1963.<br>*Reprinted from* Nursing Times, Sept./Oct. 1963. |
| Cook, D. L. | A glossary of teaching machine terms.<br>Purdue, Purdue University, Oct. 1960, mimeo. |
| Cook, D. A. | Problems of training and retraining.<br>*Reprinted from* A.M.A. Management Bulletin, 22, 1962. |
| Cook, D. A. | Studying the performance of a program.<br>*Reprinted from* Programmed Instruction, 2, Dec. 1962. |
| Coronet Instructional Films Inc. | How Coronet Learning Programs are prepared and tested.<br>Chicago, the Company, 1963. |
| Council for Education in the Commonwealth | Note on sponsors of the conference on programmed instruction for the developing countries, March 1963, London, the Council, 1963, mimeo. |
| Craytor, J. K. and Lysaught, J. P. | Trial use of programed instruction in nursing education.<br>*Reprinted from* Nursing Research, 13, 4, 1964. |
| Crowder, N. A. | Simple ways to use the student response for program control.<br>New York, U.S. Industries, (1962?) |
| Crowder, N. A. | The rationale of intrinsic programming.<br>New York, U.S. Industries, (196?) |
| Csanyi, A. *et al.* | Programed method and response mode in a visual-oral task.<br>Ohio, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, 1964, bibliog. |

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| Deboo, J. A. W. | The shorter engineering apprenticeship.<br>*Reprinted from* Machine Shop and Engineering Manufacture, April 1965. |
| Deterline, W. A. | Human systems and programed instruction.<br>*Reprinted from* American Behavioral Scientist, Nov. 1962, pp. 56-59, bibliog. |
| Deterline, W. A. | A practical course in educational psychology via programed instruction: a paper presented at the Annual Convention of the American Psychological Association, Philadelphia, August, 1963. |
| Deterline, W. A. | Learning theory, teaching and instructional technology.<br>*Reprinted from* Audiovisual Communications Review, 13, 4, 1965. |
| Deterline, W. A. | Learning theory, teaching and instructional technology: a paper presented to the American Management Association Conference on educational technology, New York, July 1965. |
| Deterline, W. A. | Characteristics of programed instruction.<br>Los Altos, General Programed Teaching Corporation. |
| Devereux Foundation | Information bulletin: automation in vocational training of mentally retarded and/or mentally ill adolescents.<br>Devon (Penn.), the Foundation, (1964?) |
| De Wet, D. R. | A multi-choice instructional device.<br>*Reprinted from* Psychologia Africana, 10, 1964, pp. 219-235, bibliog. |
| Dodd, B. T. | Programmed learning against the clock.<br>*Reprinted from* New Education, 1, 7, May 1965. |
| Dodd, B. T. | Programmed instruction and apprentice training.<br>*Reprinted from* Machine Shop and Engineering Manufacture, June, 1965. |
| Dodd, B. T. | The control of training system design.<br>Sheffield, the University of Sheffield, n.d. |
| Dorothy, Sr. Mary | A venture in programmed instruction.<br>*Reprinted from* The Catholic Educator, Feb. 1964, pp. 551-553. |
| Doty, B. A. and Doty, L. A. | Program instruction effectiveness in relation to certain students.<br>*Reprinted from* J. educ. Psychol. 55, 6, 1964, pp. 334-338 bibliog. |
| Du Pont Company | Programed instruction at Du Pont.<br>*Reprinted from* Du Pont Magazine, Jan.-Feb. 1963. |
| Deaton, D. K. | Teaching machines.<br>*Reprinted from* Curriculum Bulletin, 17, 211, March 1961 bibliog. |
| Eigen, L. D. | The construction of frames of an automated teaching program.<br>New York, Center for Programed Instruction, 1960. |
| Eigen, L. D. | Technology and educational practice: paper presented to the American Psychological Association Convention, 1961.<br>New York, Center for Programed Instruction, 1961 bibliog. |
| Eigen, L. D. | Some problems in field testing programs for teaching machines.<br>*Reprinted from* J. educ. Soc., n.d. |
| Eigen, L. D. and Komoski, P. K. | Teaching machines can aid the schools to make better use of teachers' time.<br>*Reprinted from* Calif. J. sec. Educ., 35, 4, April 1960. |
| Ellson, D. G *et al.* | Programed tutoring: a teaching aid and research tool.<br>Bloomington, Indiana University, Aug. 1965, bibliog |
| Encyclopaedia Britannica Ltd. | School-tested programed courses introduced in math and languages.<br>New York, the Company, 1961. |
| Encyclopaedia Britannica Ltd. | Progress report 1963.<br>London, the Company, 1963, mimeo. |
| Encyclopaedia Britannica Ltd. | Case history report: Temac programed learning materials.<br>New York, the Company, n.d. |
| Encyclopaedia Britannica Ltd. | A background memorandum on programed learning.<br>New York, the Company, n.d. |
| Evans, J. L. *et al.* | The only system for the construction of programed learning sequences.<br>*Reprinted from* J. Ed. Research, 55, 9, June-July, 1962, pp. 513-518. |
| Evans, J. L. *et al.* | An investigation of 'teaching machine' variables using learning programmes in symbolic logic.<br>*Reprinted from* J. Ed. Research, 55, 9, June-July 1962. pp. 433-452 bibliog. |
| Evans, J. L. and Tosti, D. T. | What happened to the educational revolution?<br>Albuquerque, Teaching Materials Incorporated, (1961?) mimeo. |
| Flexer, A. S. *et al.* | Preliminary evaulation of a self-diagnostic programed review of mathematics for introductory college science courses: a report submitted to the Carnegie Foundation, Dec. 1964.<br>New York, the Carnegie Corporation, 1964. |
| Forbes, J. E. | A new look at programed texts and their uses.<br>New York, Encyclopaedia Britannica, 1965. |
| Frase, L. T. | The effect of social reinforcers in a programed learning task: group and organizational factors influencing creativity.<br>Urbana, University of Illinois, Sept. 1963, bibliog. |
| Frincke, G. L. and Stolurow, L. M. | Three methods of processing student response data in programed instruction.<br>Urbana, University of Illinois, July 1964, bibliog. |

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|---|---|
| Fuchs, F. H. | The impact of teaching machine technology upon human instruction.<br>Culver City, Hughes Aircraft Co., May 1962, bibliog. |
| Gage, N. L. | Toward a cognitive theory of teaching.<br>*Reprinted from* Teachers College Record, 65, 5, Feb. 1964, pp. 408-412, bibliog. |
| Galanter, E. S. | The mechanization of teaching.<br>*Reprinted from* Bull. Nat. Assn. Sec. Sch. Princ., 44, 275, April 1960, pp. 301-309. |
| Galanter, E. S. | Two models of the student.<br>*Reprinted from* Teachers College Record, 62, 3, Dec. 1960, pp. 187-194, bibliog. |
| Gilbert, T. F. | Teaching a simple verbal chain.<br>Atlanta, Communicable Diseases Center, n.d. |
| Gilbert, T. F. | Training objectives in education: a dialogue between teaching and testing.<br>Atlanta, Communicable Diseases Center, n.d. |
| Gilbert, T. F. | Behavior principles for teachers.<br>Atlanta, Communicable Diseases Center, n.d. |
| Glaser, R. | Principles and problems in the preparation of programed learning sequences.<br>Pittsburgh, University of Pittsburgh Dept. of Psychology, Sept. 1960. |
| Glaser, R. | Learning and the technology of instruction.<br>*Reprinted from* Audiovisual Communications Review, 9, 5, Sept.-Oct. 1961, pp. 42-56. |
| Glaser, R. | Programed instruction—a behavioral view.<br>*Reprinted from* Behavioral Scientist, Nov. 1962, pp. 46-51. |
| Glaser, R. | Eleven untenable assumptions of college instruction: a paper presented at the University of Michigan, Mar. 13, 1963.<br>Pittsburgh, the author, 1963. |
| Glaser, R. | Variables in discovery learning: a paper presented to the Conference on Learning by Discovery, New York, Jan. 28-29, 1965.<br>Pittsburgh, the author, 1965. |
| Glaser, R. | Towards a behavioral science base for instructional design.<br>*Reprinted from* Glaser R. (ed.) Teaching Machines and Programed Learning: II Data and Directions.<br>Washington, National Education Association, 1965. |
| Glaser, R. | Instructional technology in the measurement of learning outcomes.<br>*Reprinted from* Amer. Psychol. 18, 8, n.d. |
| Glaser, R. | Individualized learning: notes on a rationale.<br>Pittsburgh, Learning Research and Development Center, n.d., mimeo. |
| Glaser, R. *et al.* | An evaluation of multiple tracks in a linear program.<br>Ohio, Aerospace Medical Research Laboratories, Oct. 1964. |
| Glaser, R. and Gow, J. S. | The Learning Research and Development Center at the University of Pittsburgh.<br>*Reprinted from* Amer. Psychol. 19, 11, Nov. 1964. |
| Glaser, R. and Schaefer, H. H. | Programed teaching.<br>*Reprinted from* Journal of Teacher Education, 12, 1, Mar. 1961, pp. 107-113. |
| Goldberg, L. A. and Murphy, J. R. | Strategies for using programed instruction.<br>*Reprinted from* Harvard Bus. Review, May-June 1964, pp. 115-132. |
| **Great Britain Department of Education and Science.** | Occasional reports on programmed learning.<br>London, the Department, April 1962 and March 1964. mimeo. |
| **Great Britain Department of Education and Science.** | Reports on education.<br>London, the Department, May, 1964. |
| **Great Britain H.M. Treasury Training and Education Division.** | Programmed learning and self-learning devices.<br>Newsletter, 2, 1963. |
| **Great Britain Department of Technical Cooperation.** | Programmed learning.<br>Reports on education, 11, May, 1964. |
| Hamer, J. W. | Enfield College of Technology survey of the use of programmed instruction in the county of Middlesex during the session 1963-64. Report No. 1, March 1965. |
| Hamilton, N. R. | Effects of logical versus random sequencing of items in an auto-instructional program under two conditions of covert response.<br>*Reprinted from* J. educ. Psychol. 55, 5, 1964, pp. 258-266, bibliog. |
| Hardie, J. | Teacher's manual for operation of the 'Sutherland' teaching machine.<br>Brora, Sutherland Education Committee, 1963, mimeo. |
| Hardie, J. | Use of the programme assembly board.<br>Brora, Sutherland Education Committee, 1963, mimeo. |
| Hardie, J. | Use of the paper rolling machine.<br>Brora, Sutherland Education Committee, 1963, mimeo. |
| Hardie, J. | Programme learning 1963-64.<br>Brora, Sutherland Education Committee, 1964, mimeo. |

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|---|---|
| Hardie, J. | Programme learning 1964-65.<br>Brora, Sutherland Education Committee, 1965, mimeo. |
| Harker, W. A. | Applications to data processing.<br>*Reprinted from* Data Processing for Management, April 1963. |
| Hartley, J. | Programmed learning in emerging nations.<br>*Reprinted from* Programmed Learning, July 1964, pp. 21-25, bibliog. (2 copies) |
| Hartley, J. | Linear and skip-branching programmes: a comparison study.<br>*Reprinted from* Brit. J. educ. Psychol. 35, 3, 1965, bibliog. |
| Hartley, J. | Research report.<br>*Reprinted from* New Education, 2, 1, 1966, bibliog. |
| Hartley, J. and Franklin, G. B. | The functional analysis of frames: proposed systems.<br>*Reprinted from* Programmed Learning, July, 1965. pp. 93-99, bibliog. |
| Harvard, University | Additions to library (series).<br>Cambridge, the University, 1964. |
| Harvard University | Selected references on programed instruction.<br>Cambridge, the University, Aug., 1965. |
| Harvard University | Evaluation sheets.<br>Cambridge, the University, 1965. |
| Harvard University | Participants List, Workshop 43, Dec. 1965.<br>Cambridge, the University, 1965. |
| Hatch, R. S. and Flint, L. N. | Programmed learning, a comparative evaluation of student performance variables under combinations of conventional and automated instruction.<br>*Reprinted from* J. educ. Psychol., Mar. 1962, bibliog. |
| Hawkridge, D. G. | Education and technology in the African context.<br>*Reprinted from* J. educ. New Africa, 1, 1, July, 1963. bibliog. |
| Hector, W. E. | Programmed learning: nurse training<br>*Reprinted from* Nursing Times, Sept. 1963. |
| Hendrix, G. | Learning by discovery.<br>*Reprinted from* The Mathematics Teacher, 54, 5, May, 1961. |
| Hendrix, G. | The psychological appeal of deductive proof.<br>*Reprinted from* The Mathematics Teacher, 54, 7, Nov. 1961. |
| Herbert, J. | The use of machines in the classroom.<br>*Reprinted from* Teacher in Wales, 5, 1964. |
| Hershberger, W. *et al.* | Self-evaluational responding and typographical cueing: techniques for programing self-instructional reading materials.<br>*Reprinted from* J. educ. Psychol. 55, 5, 1964. pp. 288-296, bibliog. |
| Hershberger, W. *et al.* | Typographical cueing in conventional and programed texts.<br>*Reprinted from* J. appl. Psychol. 49, 1, 1965, pp. 55-60, bibliog. |
| Hershberger, W. A. and Terry, D. A. | Delay of self-testing in three types of programed text.<br>*Reprinted from* J. educ. Psychol., 56, 1, 1965, pp. 22-30, bibliog. |
| Hively, W. | Programing stimuli in matching to sample.<br>*Reprinted from* J. exp. Analysis Behav., 5, 3, July, 1962. pp. 279-298, bibliog. |
| Hively, W. | Specifying terminal behaviour in mathematics.<br>Harvard, Committee on Programed Instruction, (1964?), bibliog. |
| Hively, W. *et al.* | Progress report: research and development in programed instruction.<br>Cambridge, Harvard University Committee on Programed Instruction, June 1965, bibliog. |
| Holland, J. G. | Human vigilance: the rate of observing an instrument is controlled by the schedule of signal detections.<br>*Reprinted from* Science, 128, 3315, July 1958, pp. 61-63, bibliog. |
| Holland, J. G. | Teaching machines: an application of principles from the laboratory.<br>*Reprinted from* J. exp. Analysis Behav., 3, 4, Oct. 1960, pp. 275-287, bibliog. |
| Holland, J. G. | Evaluating teaching machines and programs.<br>*Reprinted from* Teachers College Record, 63, 1, Oct. 1961, pp. 56-65. |
| Holland, J. G. | New directions in teaching-machine research.<br>*Reprinted from* Coulson, J. E. (ed.) Programmed learning and computer-based instruction.<br>New York, Wiley, 1962. |
| Holland, J. G. | *Review:*<br>Lumsdaine, A. A. and Glaser, R.: Teaching machines and programmed learning: a source book.<br>Contemp. Psychol. (1962?) |
| Holland, J. G. and Kemp, F. D. | A measure of programing in teaching-machine material.<br>*Reprinted from* J. educ. Psychol. 56, 5, 1965, pp. 264-269 (3 copies) |
| Holland, J. G. and Porter, D. | The influence of repetition of incorrectly answered items in a teaching-machine program.<br>*Reprinted from* J. exp. Analysis Behav., Oct. 1960, pp. 305-307, bibliog. |
| Holt, H. O. | Development of self-instruction programs for telephone company training.<br>*Reprinted from* Telephony 165, 21, Nov. 1963. |

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|---|---|
| Homme, L. E. | Programed instruction and the stimulus control of behaviour: a paper read at the International Conference on Learning, Teaching and Teaching Aids for Today, Berlin, July, 1963.<br>Albuquerque, Teaching Machines Inc., (1964) |
| Homme, L. E. | The Premack principle applied to tutoring: a paper read at the meeting of the New Mexico Psychological Association, May, 1964.<br>Albuquerque, Teaching Materials Inc., 1964, mimeo, bibliog. |
| Homme, L. E. | The programed peer-tutor relationship.<br>Albuquerque, Teaching Materials Inc., 1964, mimeo. |
| Homme, L. E. | Behavioral engineering in instruction systems: a paper presented at Minuteman Instructional Planning Conference, Nov. 1964.<br>Albuquerque, Teaching Materials Inc., 1964, mimeo. |
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